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THE VALUATION AND MINING FEASIBILITY OF A DEEP GOLD PLACER NEAR LIVENGOOD, ALASKA

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THE VALUATION AND MINING FEASIBILITY OF A DEEP GOLD PLACER NEAR LIVENGOOD, ALASKA

A

THESIS

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in Partial Fulfillment of the Requirements

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By

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Fairbanks, Alaska

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THE VALUATION AND MINING FEASIBILITY OF A DEEP GOLD PLACER NEAR LIVENGOOD, ALASKA

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ABSTRACT

The placer gold industry in Alaska has experienced a recent boom in activity while its mining technology has lagged behind. The objective of this thesis is to suggest and to evaluate new approaches in placer mining technology.

A computer modeling technique is presented which evaluates the reserves in the Livengood placer deposit. Sampling inaccuracies are accounted for by this method. Comparisons between modeling and conventional triangle techniques are made utilizing grade-yardage relationships and error analysis. This identifies the modeling procedure as a viable technique. A paystreak is delineated which contains reserves of 285,000 cubic yards grading 0.174 ounces/cubic yard.

An underground mining plan is proposed and tested for its feasibility. An investment of $6,100,000 is required and operating costs average $51/cubic yard over five years of production. Viability is established assuming a gold price of $600/ounce and an interest rate of 14%.

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INTRODUCTION

The thesis area is located between drill lines 28 and 48 of the Livengood Creek drill grid (Yukon Placer Mining, Inc., 1956) in the mid-section of the Livengood Creek gold placer. The placer deposit is a high gravel bench overlain by a thick layer of wind-blown loess and organics. The entire gravel and silt section is permanently frozen. Paystreaks within the deposit are noted for their spotty, rich character and concentration close to the bedrock interface.

A particularly rich paystreak about 3000 feet long and 500 feet wide has been delineated by computer modeling procedures. For reference, this is termed the U-G orebody and is the focus of this thesis. A hypothetical mine plan utilizing underground extraction techniques is proposed to exploit this deposit. The feasibility of this technique is rigorously tested in a detailed economic analysis.

Scope of the Thesis

The valuation parameters are determined for the Livengood deposit utilizing computer isopach techniques, a straightforward, simple modeling procedure which recognizes the inherent error in churn-drill sampling. For reference, all gold values reflect a standard gold price of 35 dollars per troy ounce. While this is much less than the present price, it is a base price which is fixed throughout the valuation procedure.

All capital and operating costs required to exploit the U-G orebody are estimated and tabulated. In order to reliably determine the project's viability, all costs are conservative and reflect contingencies, inflation and other increases.

Finally, the attractiveness of the venture is determined by comparing the annual revenues and cash flows with the initial required expenditure. By discounting all net cash flows to the present, investment values at several gold prices can be found.

Location, Climate and Geography of the Livengood Area

Livengood Creek is located in the interior of Alaska, in the Tanana river drainage of the Yukon River watershed. It is within the Tolovana Mining District and is about 60 miles north of Fairbanks as shown on Figure 1. The Elliot Highway, a year-round gravel road, connects Livengood to Fairbanks.

The topography near Livengood is characteristic of the Yukon - Tanana uplands. Broad, even ridges, generally over 2000 feet in elevation, rise above sluggish, meandering streams in wide valleys. Vegetation consists of low, black spruce in the valleys and northern slopes, and alder, white spruce, aspen and birch along the southern slopes. The photograph in Figure 2 typifies the topography.

The climate in the area is extreme, characterized by summer days with temperatures capable of rising to 90°F contrasting sharply with winter temperatures ranging to -50°F. Precipitation in the area is low, averaging between 10 and 20 inches annually.

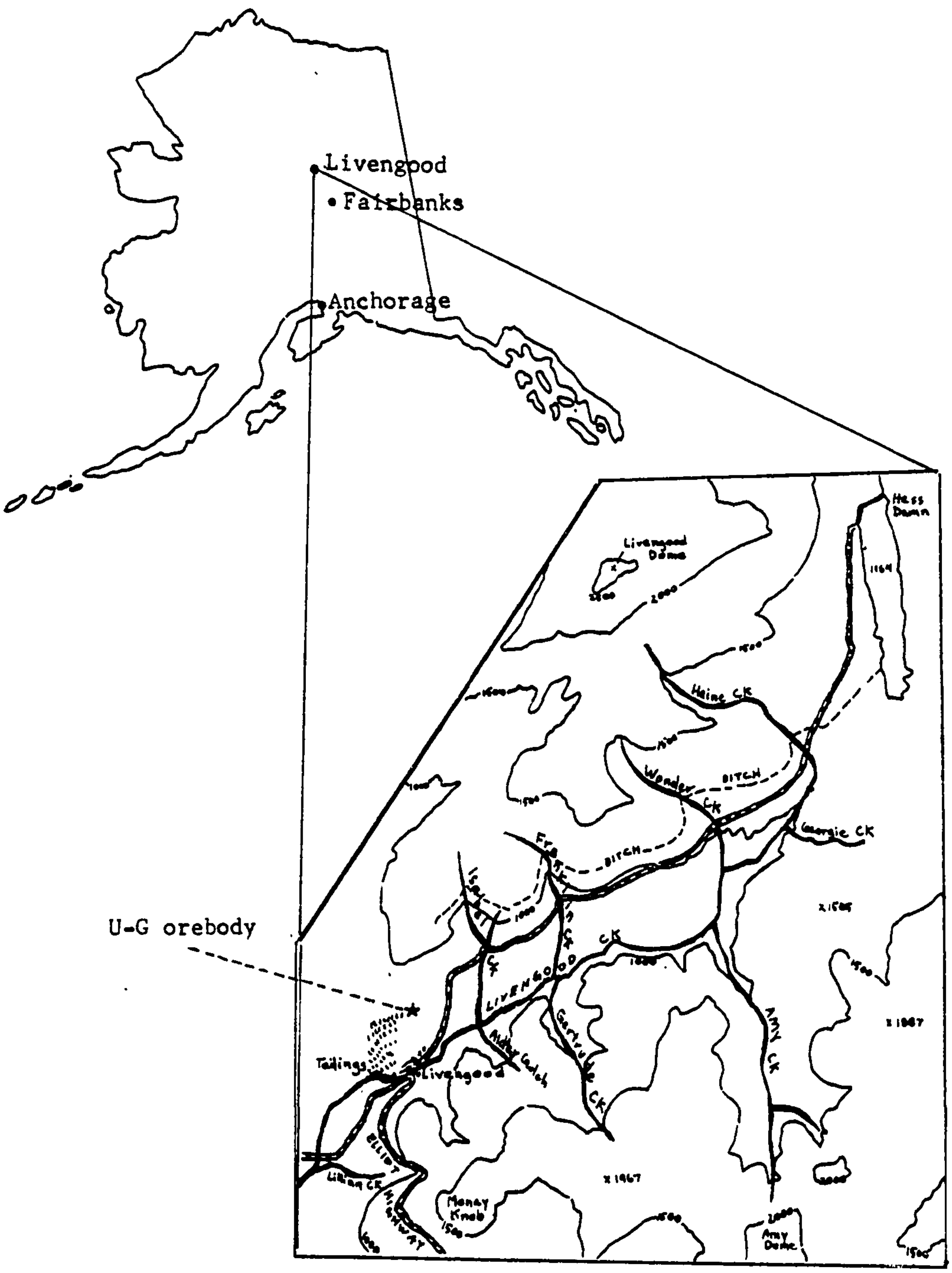


Figure 1. Location of Livengood Creek.

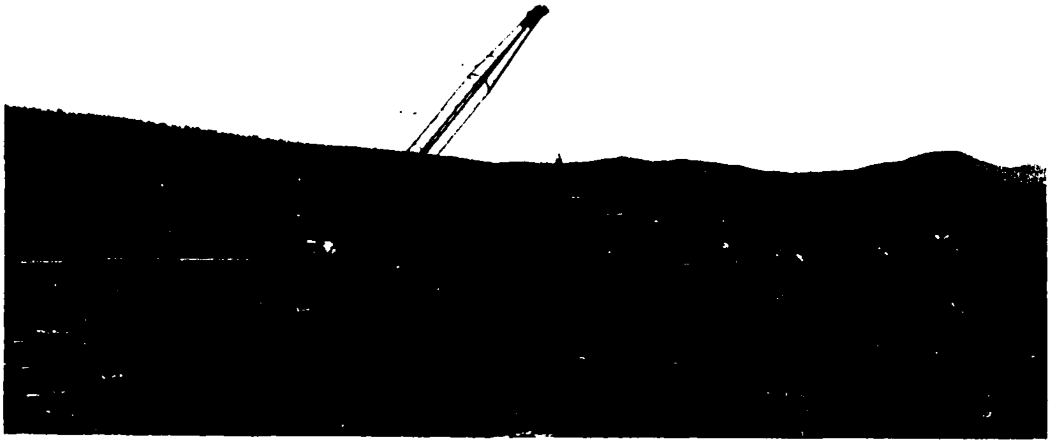


Figure 2. Segment of the Livengood gold placer.

Geology of the Livengood Area

Most of the Yukon-Tanana uplands are underlain by undifferentiated paleozoic metasediments and metavolcanics. This is typical of the Livengood area. At Livengood, cherts and limestones are the predominant country rock. Ultramafic bodies at Any Dome and Money Knob have intruded through the country rock. Veinlets of quartz and calcite reportedly contain gold near this intrusion, at the head of Ruth, Lillian, and Olive Creeks. Early work postulated this to be part of an area of mineralization localized on the ridge between Livengood Creek and the Tolovana River, hence the main source of gold on Livengood Creek. (Mertie, 1916.)

Three types of Quaternary materials have been identified in the Livengood area, these are gravels, silts, and residual talus. The gravels can be sub-divided into older bench deposits and recent gravels in present stream systems.

The older gravels on Livengood Creek consist of well-rounded gravels with clast size ranging from one inch to a foot in diameter. The older gravel is composed primarily of chert and limestone boulders, with a minor component of igneous rock. The thickness of these gravels range between 4 and 35 feet and they are the predominant auriferous gravels in Livengood Creek. Without exception, the gold is concentrated in the lower part of the gravels close to the interface with the bedrock. (Personal communication, Bruce Thomas.)

The recent gravels have been worked for gold on Amy Creek, Gertrude Creek, Ruth Creek and the southern side of Livengood Creek. Their gold content is derived from the reworking of older gravels and recent erosion of mineralized rock. These gravels are not important within the thesis area. These areas are all shown on Figure 1, in addition to the location of the U-G orebody.

Overlying the bench gravels in Livengood Creek, as in the Fairbanks district, is a thick section of organics and wind-blown silt commonly referred to as muck. This consists of fine particles, frozen, and seamed with taber ice. Within the thesis area, the muck thickness ranges from 20 to 100 feet. The entire section of bench gravel and muck is permanently frozen. (Overbeck, 1918.)

History of the Livengood Area

The initial gold discovery was made in the Livengood district in 1914 by Jay Livengood and N.R. Hudson. After this discovery, regular mining operations started up quickly. Production peaked in 1917 and quickly declined thereafter, due mainly to a rise in costs associated with the war and a lack of water (Smith, 1922). After World War I production slowly increased but was hampered by several dry seasons which delayed summer washing of previous winters' production for a year or two (Smith, 1930).

In 1934 interest began to develop around a dredge feasibility study on Livengood Creek. Churn-drilling on the bench gravels started in 1936 (Smith, 1939). In 1939 work commenced on a water project to utilize a dam on Hess Creek and a long underground flume-way to the head of Livengood Creek (Smith, 1941). A six-cubic-foot dredge was transported to Livengood Creek in early 1940 and was assembled and put into production by early September of the same year (Smith, 1942). In 1954 this dredge was idle and soon afterward was sold and removed from the property (Kern, 1955). From 1955 and into the 1960's a non-float, bulldozer-dragline operation recovered gold from the shallow recent gravels (Kern, 1956). At present, churn-drilling and limited production are being carried on in anticipation of a large-scale non-float surface stripping operation.

The greatest amount of gold produced from the deep gravels has been by underground drift-mining methods. At the peak of mining, about 270 workers were employed in 35 separate sub-surface operations (Overbeck, 1918). The conditions for underground mining were considered at the time to be excellent, due to many factors. Firstly, the ground is solidly frozen from the surface to the bedrock, requiring little or no timbering for support. Secondly, no underground water is encountered at or near bedrock to cause uncomfortable mine conditions. Finally, the consistant nature of the gravel zone with the lack of silt interbeds or lenses prevents slabbing in the stopes. After many years, untimbered workings were found to be intact by the U.S. Geological Survey. The gravels at Livengood were considered to be much more economic to extract then those in the Fairbanks District. (Mertie, 1916.)

The procedure for drift-mining consisted of sinking a shaft and driving drifts in the direction parallel to the length of the pay-streak. At the ends of these drifts, crosscuts were driven to the lateral extent of the paystreak. Gravel was then extracted by long-wall-retreat stoping.

The ground was thawed locally with six to eight foot long steam points. This thawed gravel was then picked loose and loaded into wheelbarrows. These were then hand-trammed to the shaft and hoisted to the surface. A ginpole configuration allowed the gravels to be piled in a conical dump above a pre-erected sluice box. Washing of the gravel took place in early summer. The break-even cost of drift mining at Livengood ranged between 35 to 50 cents per square foot at 20-67 dollar gold (Mertie, 1916). This is equivalent to 60 to 88 cents per square foot at 35 dollar gold and 7 to 10 dollars per square foot at 600 dollar gold. Figure 3 shows a cross-section of a typical drift mining operation.

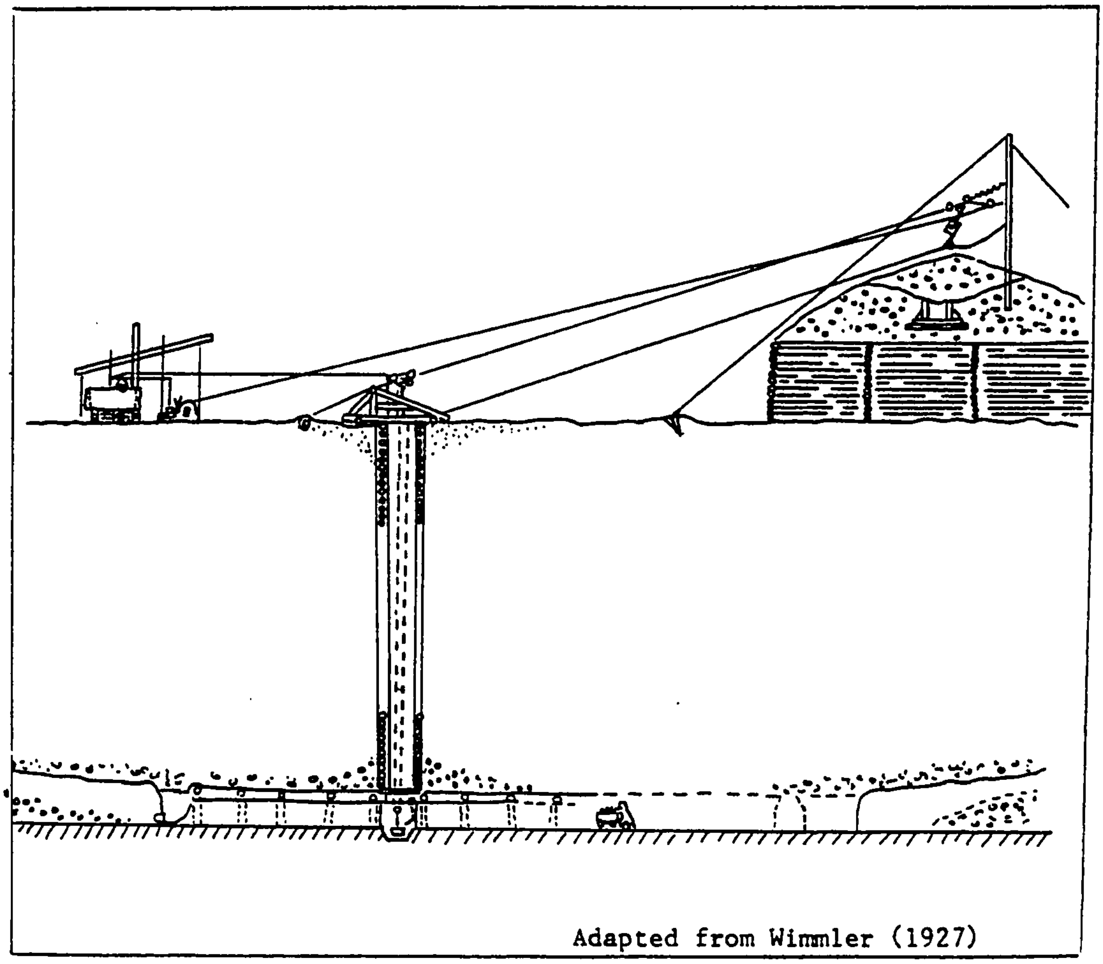


Figure 3. Cross-section of a former drift mining operation.

VALUATION

Computer Modeling - Concepts and Procedures

Computer modeling of the economic parameters in a placer deposit can be a very useful tool. These parameters can be readily derived from drill-hole results obtained from testing the deposit. The most efficient use of extensive exploration data is achievable while holding the analytical costs to a minimum.

Prior to profiling and valuation, a computer program which effectively models the parameters must be developed. Since this is a primary step which directly affects the final valuation results for the placer, it is critical that the profiles provide an accurate reflection of the data. The relatively poor quality of the data inherent in placer evaluation drilling due to gold size differences, hole volume and quality, and statistical reliability must be recognized. This is due to many factors. First, the variation in the weight of gold particles recovered in the sample creates uncertainty with respect to the representation of that hole to surrounding areas. Secondly, uncertainty in the true volume of the sample may raise doubts as to the representation of the drill hole. Lastly, the very nature of drill hole data may be held suspect, since the volume of core samples is so infinitely small in comparison to the volume of the mining blocks. All these factors will cause the variance between drill-hole values to be so high that statistically reliable estimates of the reserves cannot be made. (Davis, 1973.)

The given knowledge of the poor data quality influences the selection of the computer model. During the entire process of modeling, profiling, and valuating, the nature of the sampling should be recognized, and therefore, all estimates should reflect a conservative approach. In the final valuation, errors and their sources should be analyzed, followed by appropriate revisions in the final reserves to reflect these errors.

The Surface II computer system at the University of Alaska, Honeywell Center, was employed to profile the economic parameters of the Livengood placer deposit. The Surface II system is a combination statistical-plotting package specially designed for earth and biological sciences. Programs must be written conforming to the system which present the sample data in grid form and operations must be performed as specified within the program.

The first step is to put the sample data into a grid format. Since this grid represents selective mining blocks, the size and shape is of utmost importance. Choosing the size of the blocks involves a trade-off between accuracy and computation time. The blocks should be made as small as possible to selectively estimate point values while at the same time recognizing that computation time will exponentially increase with a decrease in block size. The shape of the block should reflect the trend of the paystreaks within the placer. The long side of the block should be parallel to the long axis of the paystreak. The width of the blocks should not exceed the expected width of the paystreaks. As an example, if the long axis of the average paystreak, estimated from prior or present mining on that particular drainage, is five times as long as the short axis, then the length of each mining block should be five times longer than the width. This is important to the modeling during the estimation of blocks between drill holes. The weighting and estimating of these blocks should be in relation to the expected geological influences affecting the paystreaks.

Once the deposit has been gridded and the data has been filed into the computer, an algorithm providing two weighting functions must be developed and programmed. The first is a distance function which provides an initial value for all mining blocks based on sample values in surrounding blocks. The purpose of this is to decrease the relative weight of drill-hole values as the distance between that drill-hole and the mining block increases. The second function averages the actual sample points by means of a weighted average of the dip projections of the values at each drill hole. This will reestimate values at each drill hole and provide estimates of values between drill holes. (Sampson, 1978.) For the Livengood data, an inverse distance-squared function is employed for the distance weighting and a distance weighted average is used for the average smoothing function.

The purpose of these weighting functions is to take data which may not be reliable and purposely revalue anomalous drill holes. Since there is such a wide variation in the drill hole data for gold values per square foot, the averaging function will devalue the observed sample values and substitute a lower grade estimated sample value. The effect of this is seen by the flattening trend of the relationship between observed and predicted sample values, shown in Figure 4. Some parameters to be useful for project engineering, such as overburden thickness, do not show a wide variation between drill holes, and greater confidence can be placed upon the observed values. The averaging function will not produce a large variation between estimated and observed sample values in such cases, as seen in Figure 5.

Another feature of the averaging function is the heteroskedastic nature of the observed - predicted value relationship. The downward trend of the predicted gold values affects only relatively high value samples, while predicting values close to observed sample values for the majority of the samples. Figure 6 is a plot of the observed sample values against the residuals between the observed and predicted values. The residual values become large only at sample values greater than \$6/S.F.. Overburden residuals would not be expected to display this heteroskedasticity due to the low variation between samples. Figure 7 displays this expectation. While large variances and absolute errors may be expected from the gold value data, the overburden and gravel errors can be expected to be fairly small.

Table 1 lists the error analysis of each parameter. As predicted from Figure 6 and 7, the errors for gold values are high at 16% absolute error while overburden and gravel errors are less than 2%. The differences in correlation values between observed and predicted values for the three parameters are also noted. The actual breakdown of the gold value error will be discussed later with reference to lognormal distributions.

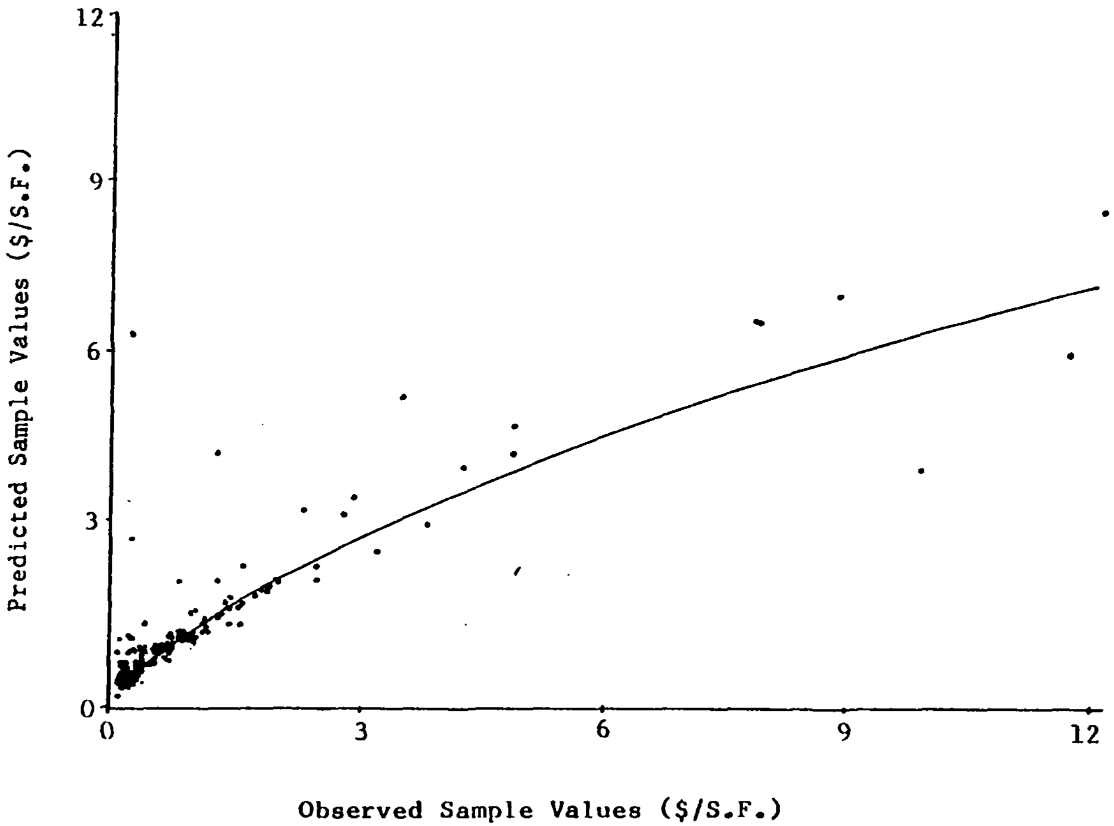


Figure 4. Observed sample values vs. predicted values - Gold values per square foot.

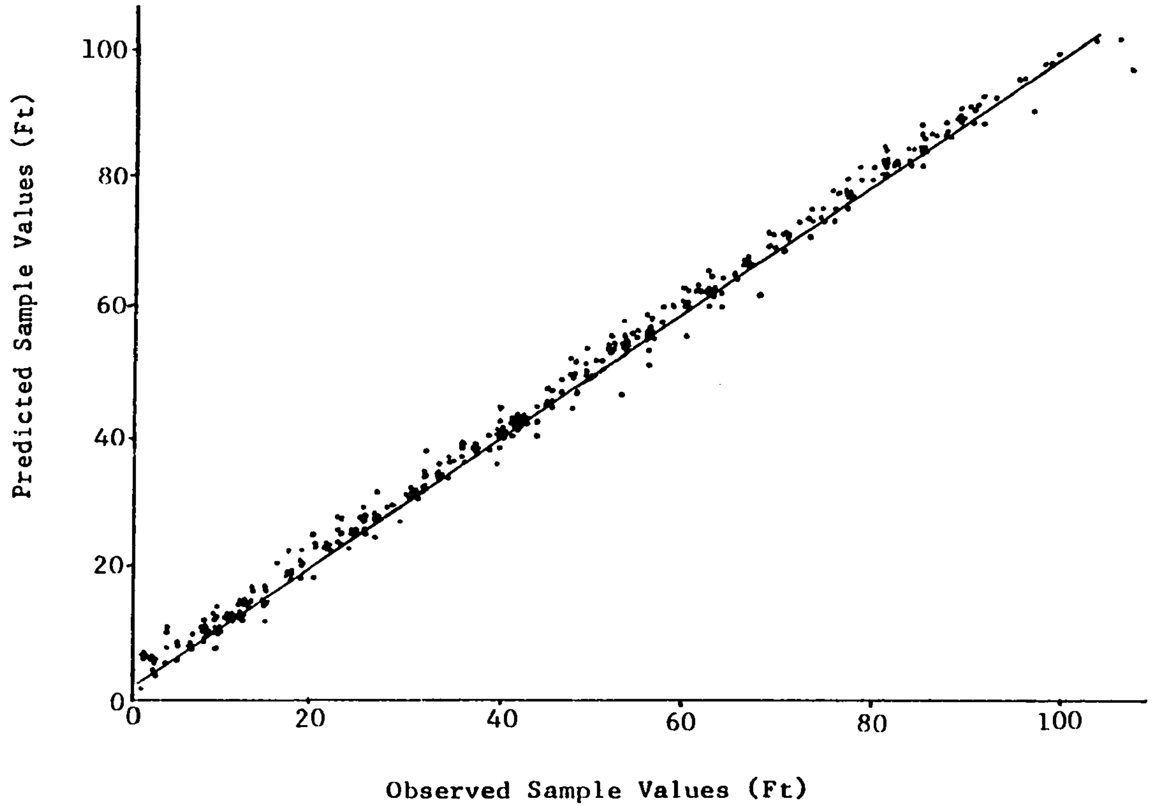


Figure 5. Observed sample values vs. predicted values - Thickness of overburden.

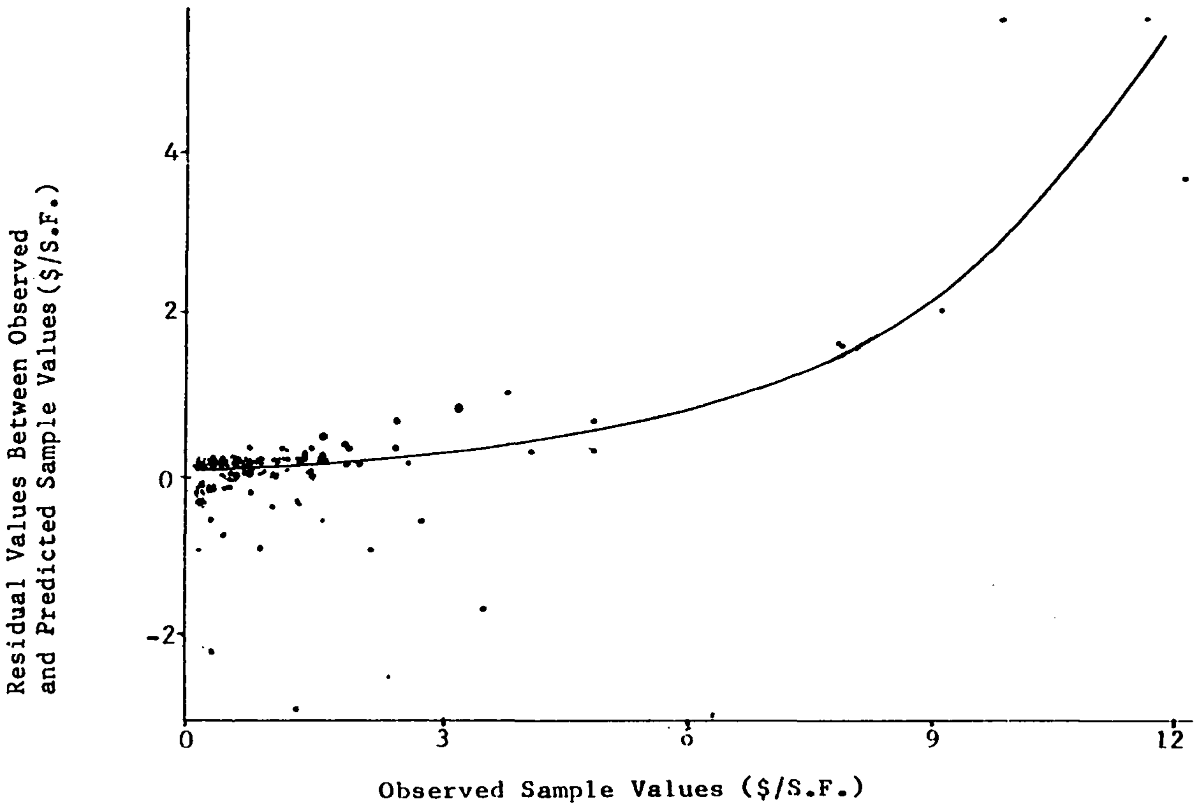


Figure 6. Observed sample values vs. residuals between observed and predicted values - Gold values per square foot.

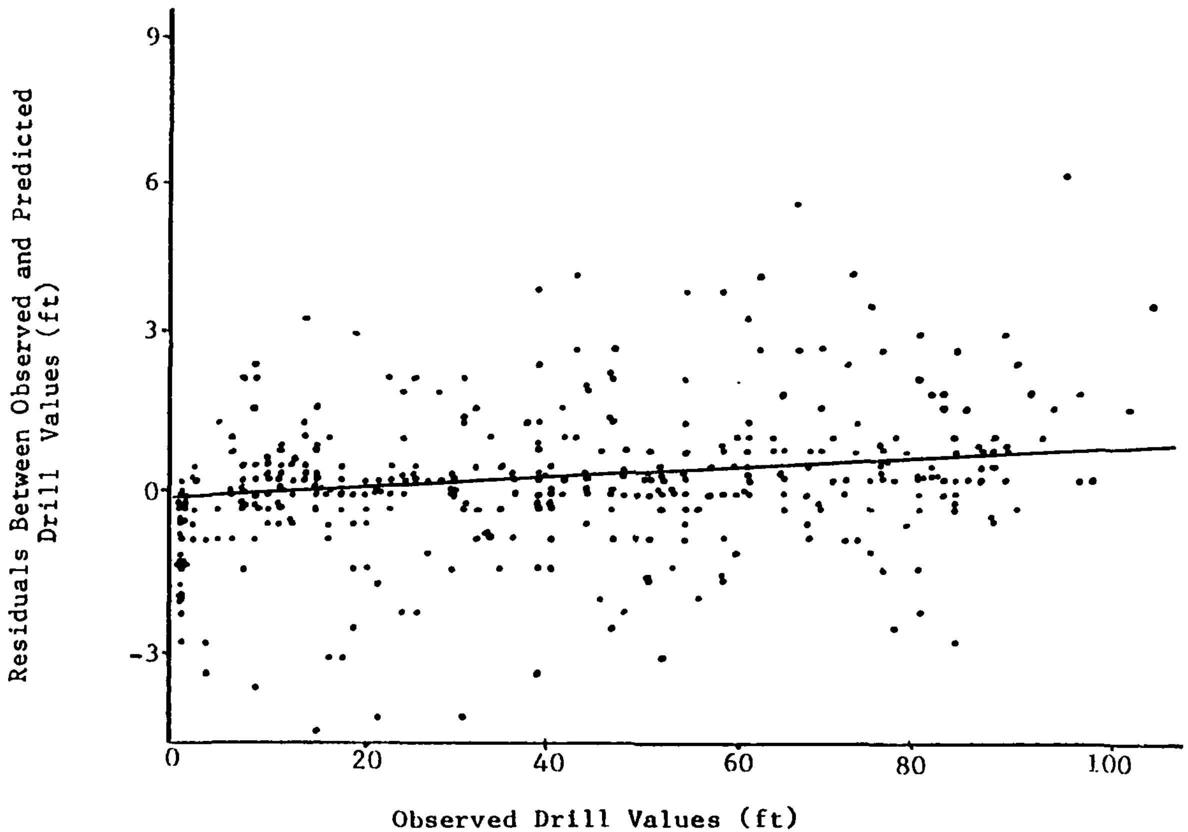


Figure 7. Observed sample values vs. residuals between observed and predicted values of thickness of overburden.

Table 1. Error analysis of gold values/S.F., overburden and gravel thickness from computer profiling.

	Gold Values	Overburden	Gravel
Mean Error	0.1455 $/S.F.	1.0399 ft	0.8895 ft
Standard Deviation	0.5267 $/S.F.	1.5945 ft	1.2603 ft
Variance	0.277 $/S.F.	1.2088 ft	1.5884
% Absolute Error	16.7487%	0.168%	1.1821%
Correlation between observed and predicted values	0.9213	0.9987	0.9937

Comparison of Techniques

Block Valuation, Procedure and Results

The most widely used technique for making preliminary reserve estimation on placer ground is the double end area or block valuation procedure. Using relatively few calculations, total volumes of overburden and gravel in addition to total gold values can be homogeneous paystreaks, block valuation may be as accurate as more refined estimating procedures. As the sample variance decreases, the need for smaller sample units will lessen since the samples will more accurately reflect the actual deposit parameters.

There are several problems inherent in double-end area estimation. Reserve estimates cannot be accurately checked with clean-up data since the blocks are so large and in practice, a block may represent more than one year of production. Smaller sampling units must be employed even in homogeneous deposits if recoveries are to be meaningfully checked against estimates.

Blocks are selected to adequately cover the drill grid. The individual block units should be kept as small as possible, but not so small that the important consideration of minimizing calculation time is defeated. Plate 1 shows the size and positioning of the blocks over the entire Livengood drill map.

Each drill hole sample is tabulated with its respective block. The samples are weighted to prevent overvaluation of the drill holes at the block corners. In this drill-hole-weighting procedure, values located inside the corner lines are doubled. The block-end areas are each calculated with regard to their doubled value and the hole spacing. These ends are then averaged and multiplied by the spacing between the two block ends. This procedure is illustrated in Figure 8.

Appendix A shows the block tabulations and computations for the Livengood drill grid. These data are summarized and presented in Table 2. In addition, results for blocks D,G,H, and F are summarized in Table 1-B. Blocks D,G,H and F are presented since they most closely approximate the area bounded by the U-G orebody.

Triangle Valuation - Procedure and Results

Several conventional-valuation techniques exist which employ the use of polygons. The double-ended technique has already been noted and is used primarily as a reconnaissance tool for wide-spaced drill data. Other methods include the double-point triangles, the triple-point triangle and diamond techniques. The three-point triangle procedure is considered to be the most accurate of all polygon valuation techniques (Wolff, 1964). The reason for this is that each polygon block is computed from the average of three holes. The two-lined diamond technique makes use of an average of two holes, while the diamond technique only requires one hole per block. Calculations for the three-point procedure are very lengthy since each

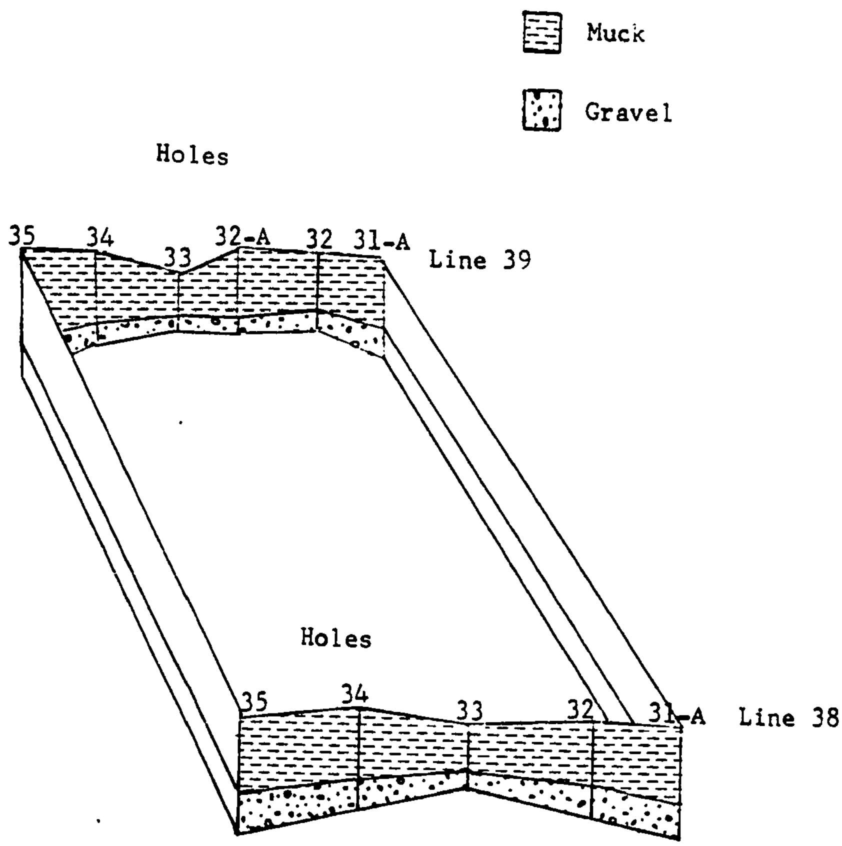


Figure 8. Diagram of sample block in double end area estimation.

Table 2. Estimated deposit parameters for the Livengood drill grid and for Blocks D,G,H, and F.

Summarized from Appendix B, based on the procedure by Doheney. (1942).

	Livengood Drill Grid	Blocks D, D, H & F
Volume of Overburden (Cubic Yards)	34,749,789	7,258,095
Volume of Gravel (Cubic Yards)	11,240,652	1,643,986
Total Gold Content (Oz)	219,267	66,964
Gravel Grade (Oz)/C.Y.)	0.0195	0.0407

triangle requires the average value of three holes. This is considered to be a very reliable technique for drill values which are erratic between holes however. In the case of large, uniform-value placers, the diamond technique is usually considered both adequate and appropriate. Picotte (1941) has recommended the use of triangle techniques by the engineering department of a mining company to check the reserve values and areas submitted by the exploration and drilling department.

The first and most critical step in triangle valuation is the selection of the size, type, and orientation of the triangles. Trends within the placer deposit should be recognized. The lengthwise direction of the triangles should follow this orientation. If there is an apparent alignment of rich drill-hole values along this trend, a special effort should be made to connect these holes with triangles.

After the triangles are laid across the drill grind, areas for each triangle must be found. In a uniform-drill grid, right-hand triangles may be produced. In this case, simple geometry can be used to find each triangle area. In most cases, irregularly-shaped triangles will cover the grid, and the area of each is more slowly determined.

The double-end area or block-valuation method presents results in blocks or areas which may not be appropriate for actual mining records. Often these blocks are so large that it may take several mining seasons to check cleanup results against predicted values. In some cases, a large section of a block is deemed unsuitable for mining. For this reason, in addition to that of greater accuracy, triangle valuation is carried out in two ways. The total overburden, gravel, and gold values for blocks D, G, F, and H are estimated. This is done in order to obtain a comparison with results obtained by block and computer isopach procedures, given a constant area to be evaluated. Next, the mining parameters for the U-G orebody are evaluated employing a cutoff grade of $0.80/S.F. at $35/oz. gold.

The parameters for each drill hole are converted and expressed as factors per square foot. Factors for overburden volume, gravel volume, and gold values per square foot are calculated. Finally, these factors are multiplied by the area of the triangles to provide a computed volume of overburden and gravel and values of gold for each triangle. The total volume and grade of the placer gravels within each triangle are estimated. The triangle calculations are listed in Appendix C.

Figure 9 shows the triangle locations for the Blocks D,G, H, and F and U-G orebodies. The results for these two triangle groups are tabulated in Table 3. The higher ore grade in the U-G mining block is apparent. This is a good example of the advantage of localizing made possible in the triangle method as opposed to double-end area valuation.

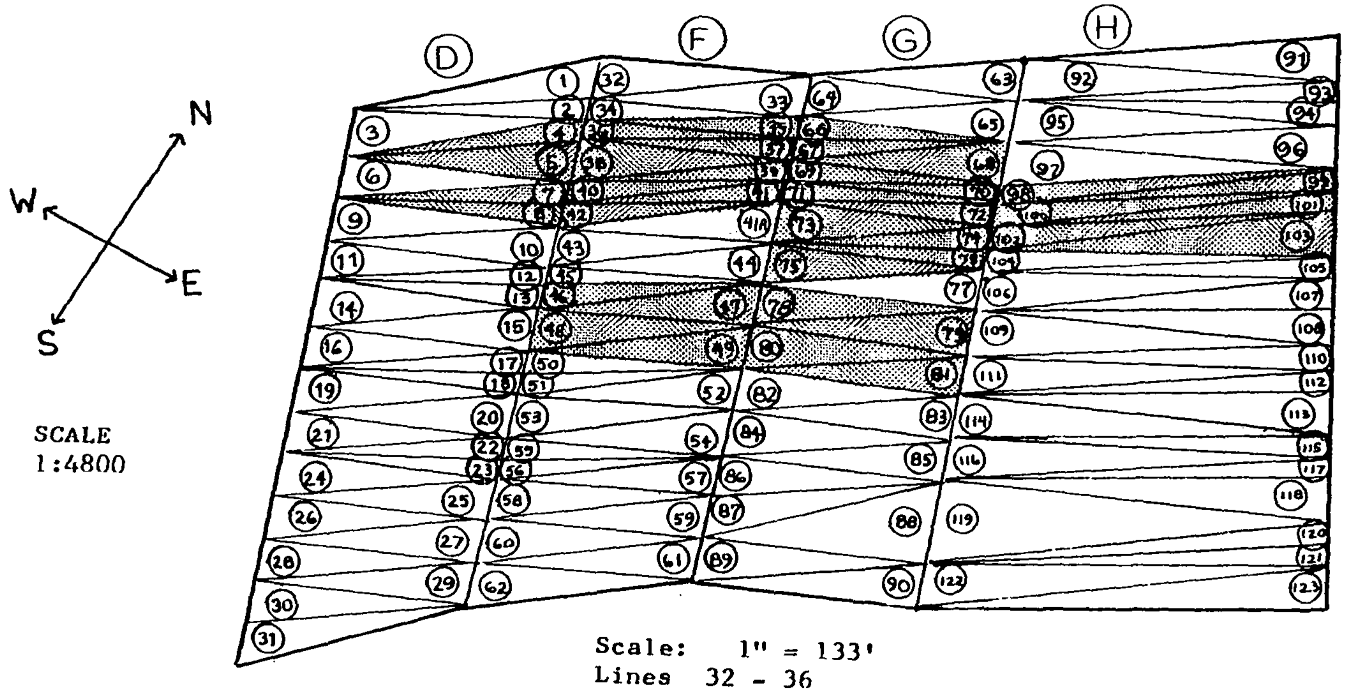


Figure 9. Block D,G,H, and F and U - G orebody (shaded) as represented by triangle valuation.

Table 3. Estimated deposit parameters fro blocks D, G, F, and H and for the U-G orebody by triangle valuation.

Tabulated from Appendix B, based on procedure by Doheny (1942).

	Blocks D, G, H, & F	U-G Orebody
Volume of Overburden (cubic yards)	7,251,435	1,866,464
Volume of Gravel (cubic yards)	1,558,413	485,410
Total Gold Content (oz)	65,229	40,363
Gravel Grade (oz/c.y.)	0.0419	0.0831
Surface Area (square feet)	3,751,600	615,500

Most of the gold within Blocks D,G,H, and F is concentrated in less than 25% of the surface area and 20% of the gravel, a factor which would not have been apparent by block valuation. Without more detailed reserve techniques, unprofitable ground may be worked which could jeopardize the entire mining operation.

Description, Procedure and Results of Computer Isopach Techniques

A quantitative valuation of gravel volume, muck volume and gold content must be made in order for the computer-generated contour maps to be of value. A means must be provided to estimate these deposit parameters accurately and efficiently. The contour lines generated by the computer programs and presented in a two-dimensional planar format can provide these factors.

Contour lines are an approximation of the distribution and concentration of physical properties within the placer deposit. Each contour line may be viewed as a slab with the enclosed surface area of that contour value the base and the contour interval the height. Since the isopachs and isolines are of equal intervals between values, the procedure for calculations is relatively simple. Given an equal thickness of intervals, the value of the volume beneath the surface can be approximated by summing all the slab volumes, each representing a specific contour interval.

Diagram A of Figure 10 shows a problem of undervaluation which must be recognized in this procedure. Since the contour lines represent the approximate surface of the deposit parameter, the slabs do not equal the total volume of the parameter, but are slightly less. This is shown by the hatched region in the diagram. To correct for this an isopach-loading factor is introduced. The purpose of this loading factor is to compensate for the under-valuation by adding a volume of one half the base slab. This is equivalent to raising each contour interval one-half step, as shown in Diagram B of Figure 10. Volumes will now be over-represented, but this will cancel any under-representations. This is signified by the double-hatched over-valued area nearly equivalent to the single-hatched over-valued area nearly equivalent to the single-hatched under-valued area.

Specifically this procedure can be stated as follows:

$$V_t = V(A_o + A_1 + \ldots + A_n) + V\ A_o/2$$

Given,

V_t = Total volume of parameter

A_o = Base area, lowest contour level

A_1 = Area of next contour level

A_2 = Area of third lowest level, etc.

A_n = Area of highest contour level

V = Constant contour interval

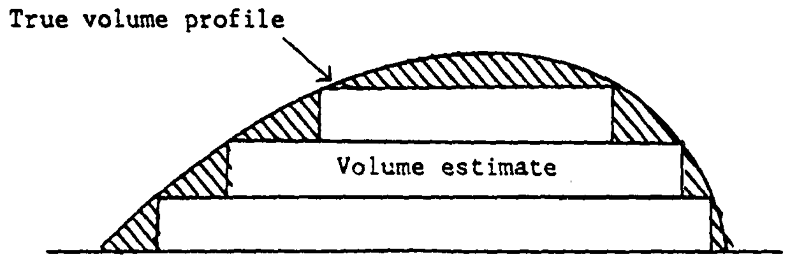


Diagram A Simple volume estimate without isopach loading factor

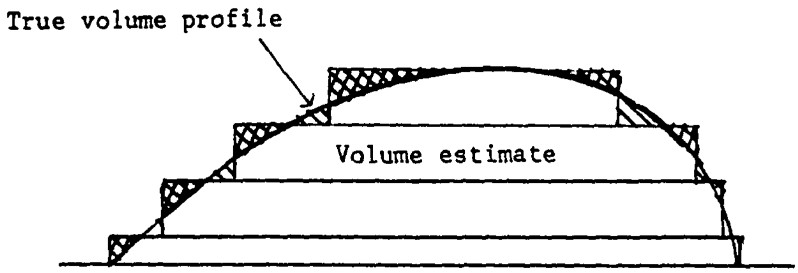


Diagram B Revised volume estimate with isopach loading factor

Figure 10. The use of the isopach loading factor to reduce under-representation of the true volume.

In this equation, $V(A_0 + A_1 + \ldots + A_n)$ is the major portion of the volume, $VA_0/2$ is the isopach loading factor.

In engineering, this procedure is useful in determining volumes of materials contained in borrow pits for road work, construction, etc. Volumes can be determined in this manner from slope stake data and irregular cross sections in addition to contour maps. (Davis, 1966.)

The Bureau of Mines has published a procedure for estimating the volume and grade of reserves by isoline analysis (Popoff, 1966). After the preparation and construction of an isograde map, the procedure is to weight the areas outlined by isolines for each grade. The weighted areas are summed together and estimates of the orebody parameters are made.

In most cases, the ore parameters will be assessed within an area defined by a set cutoff grade. In the case of the U-G orebody, this cutoff grade is set at $0.80 per square foot,* the contour increment is $0.40 per square foot.* The fact that contour slabs ranging from 10 to 70 cents per square foot exist must not be overlooked. Each of these slabs will have the same volume as the cutoff slab. The base area (A) will represent the lowest slab, or 40 cents per square foot, as opposed to the cutoff slab. This is shown in Figure 11. It is evident that the below-cutoff value slabs play an important part in the entire reserve estimation. This also

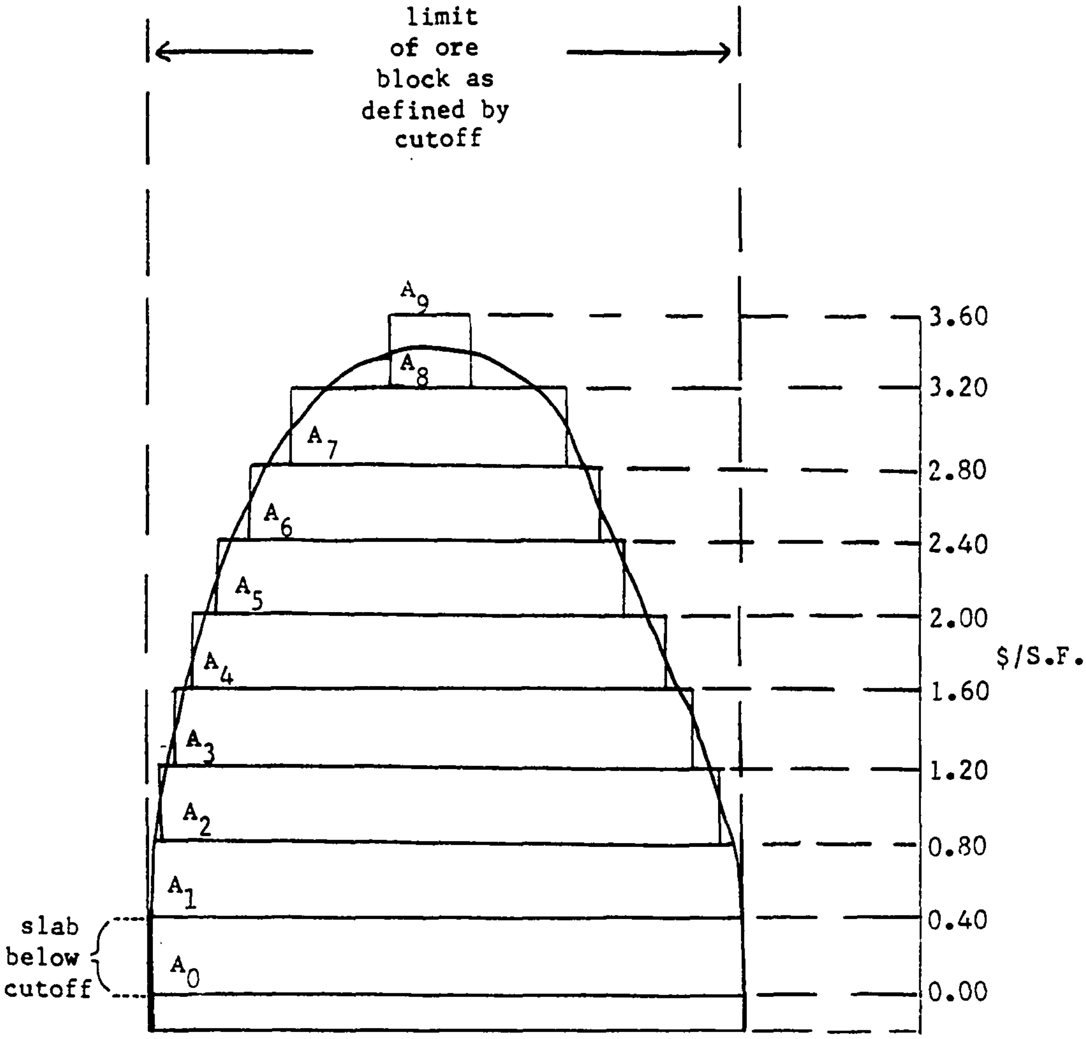


Figure 11. Example of the influence of below-cutoff value slabs on the determination of total metal values.

applies to the gravel and overburden volume estimates in the U-G orebody. The gravel and overburden profiles along the cutoff margin are greater than zero; therefore the same principle as shown in Figure 11 must be followed.

Figures 12, 13 and 14 show the contour profiles of overburden thickness, gravel thickness and values per square foot respectively. Two margins are noted, a polygon and an irregular body - the polygon is the region enclosing blocks D, F, G and H of the double-ended block valuation technique noted earlier. The irregular body marks the extent of the U-G orebody, noted by a cutoff limit of \$0.80/S.F. The results of the computer isopach technique for both these are as tabulated on Table 4. The computations are listed in Appendix D.

An attractive feature of the computer isopach technique is apparent in Figure 12, 13 and 14. The orebody is presented in a manner which permits better mine planning than through the use of polygonal techniques. The U-G orebody margins are probably more realistic than the orebody margins presented by the triangle valuation.

In general, it can be expected that contour profiling of ore reserves will give a much clearer picture of the actual shape, size and morphological features of the orebody. This can be expected to play a very important part in the design and planning of a mine plant and mining technique for use in later feasibility studies.

* Based on Gold at \$35/oz

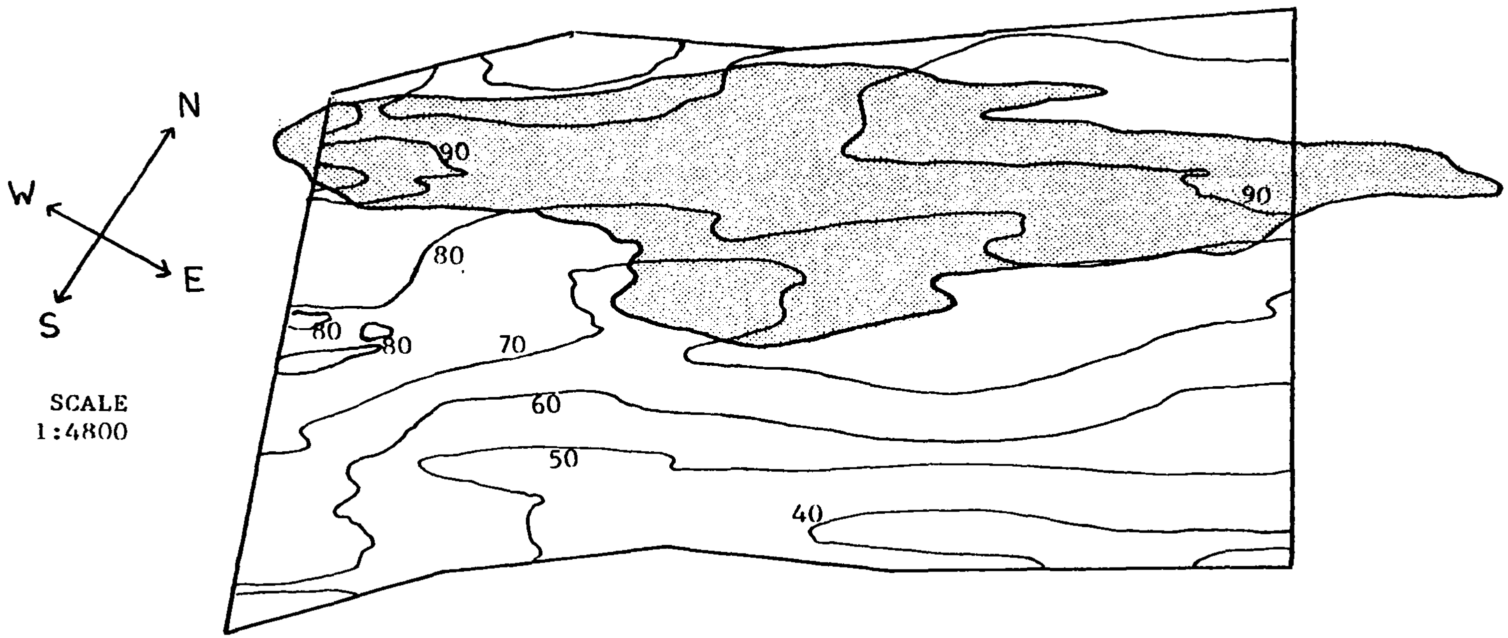


Figure 12. Overburden thickness contours (ft) within blocks D,G,H, and F and the U-G orebody (shaded).

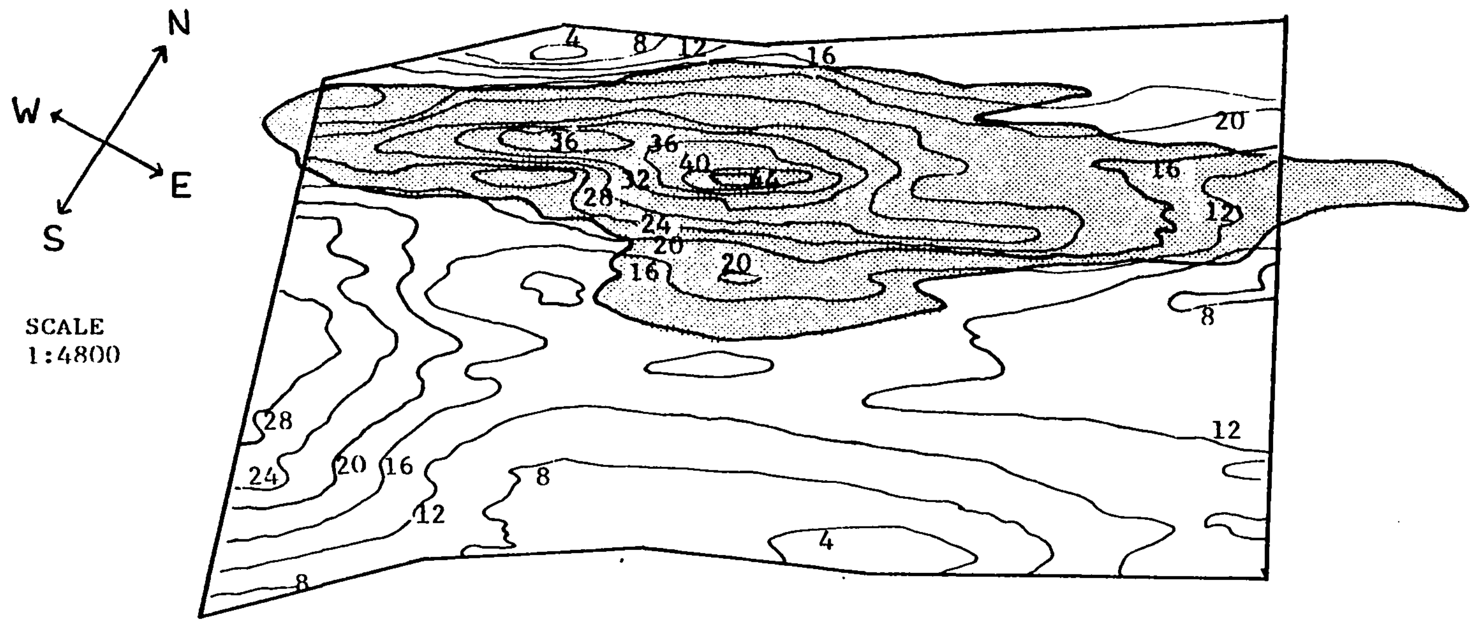


Figure 13. Gravel thickness contours (ft) within blocks D,G,H, and F and the U-G orebody (shaded).

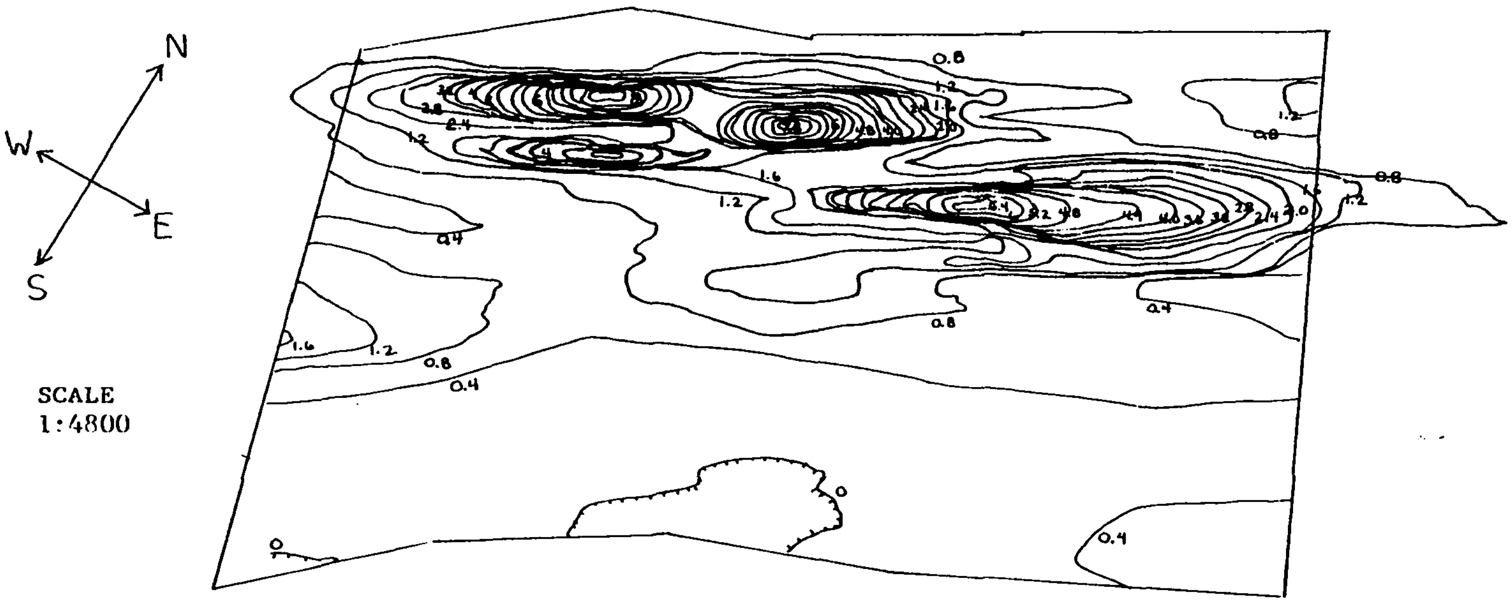


Figure 14. Gold value contours (in \$/S.F. assuming \$35/oz. gold) within blocks D,G,H, and F and the U-G orebody.

Table 4. Estimated deposit parameters for blocks, D, F, G and H and for the U-G orebody by computer isopach valuation.

Tabulated from Appendix C

	Blocks D, G, F and H	U-G Orebody
Volume of overburden (Cubic Yards)	7,186,444	2,815,481
Volume of gravel (Cubic Yards)	1,662,548	765,926
Total gold content (Oz)	67,425	55,099
Gravel grade (Oz/C.Y.)	0.0405	0.0720
Surface area (Square Feet)	2,751,600	908,600

Comparisons of Block D, G, H and F Valuation Parameters

Comparisons between the techniques can be made by grouping the results from block, triangle and isopach valuations together. Table 5 presents reserve parameters for Blocks D, G, H and F. It is clear that these values closely approximate each other. Gravel and overburden volume estimates have a maximum range of about one percent. Total and average gold contents have a higher percent range, about 3.5%.

Important implications are inherent in these values. The incremental values derived by triangle valuation sum together to values closely resembling the preliminary regional estimates derived from double-end area valuation. This means that the early exploration appraisal of the property can be treated with some degree of confidence. Secondly, the close approximation of the computer isopach results with the results obtained from conventional, proven polygon procedures lend credibility to a new, previously untried technique. The isopach loading factor, an approximation to Simpsons's Rule used in calculating volumes, allows the isopach valuation to closely duplicate independent results while reducing calculations.

While the overall tabulated results of triangle and isopach valuations may be similar, the distribution of values within the total block area derived from the methods differ. Figure 15 depicts the percent of total gold recoverable at each and every

Table 5. Comparison of results between triangle, double-end area and computer isopach techniques.

Valuation parameters for Blocks D, G, H and F

	Overburden Volume (C.Y.)	Gravel Volume (C.Y.)	Gold Content	Gravel Value (Oz/C.Y.)
Double-end	7,258,095	1,643,986	66,964	0.0407
Triangle	7,251,435	1,558,413	65,229	0.0419
Computer Isopach	7,186,444	1,662,548	67,425	0.0405
Percent difference between highest and lowest value	0.99%	1.13%	3.37%	3.46%

cutoff grade within the ore grade distribution. By definition, at a cutoff grade of zero, all potential gold reserves within blocks D, G, H and F will be recovered. Conversely, at a grade of $10/S.F., none of the potential gold reserves can be recovered by mine development using computer isopachs.

The distribution of values within blocks D, G, H and F is much smoother by computer isopach data than by triangle data as shown in Figure 15. The profile of the isopach curve reflects the inverse-distance squared weighting function which is applied in the original contour profiling. The triangle data distribution follows this distribution somewhat erratically. Generally it can be stated that the higher the variance among observed sample values, the greater the power function required in the distance weighting factor. A higher order weighting function will yield a rapidly changing gradient and used in conjunction with a planer averaging function, overvaluation by single high-value sample points may result. By applying a second order weighting function with a dip projecting averaging function, high value drill-holes make up less than 10% of the total gold reserves as shown in Figure 15. (Sampson, 1978.)

The widely fluctuating distribution of the triangle values compared to the relatively smooth isopach value distribution results in large reserve variations at different cutoff values. At the eighty cent cutoff value employed on the U-G orebody, 72% of the potential gold content is extractable according to isopach valuation.

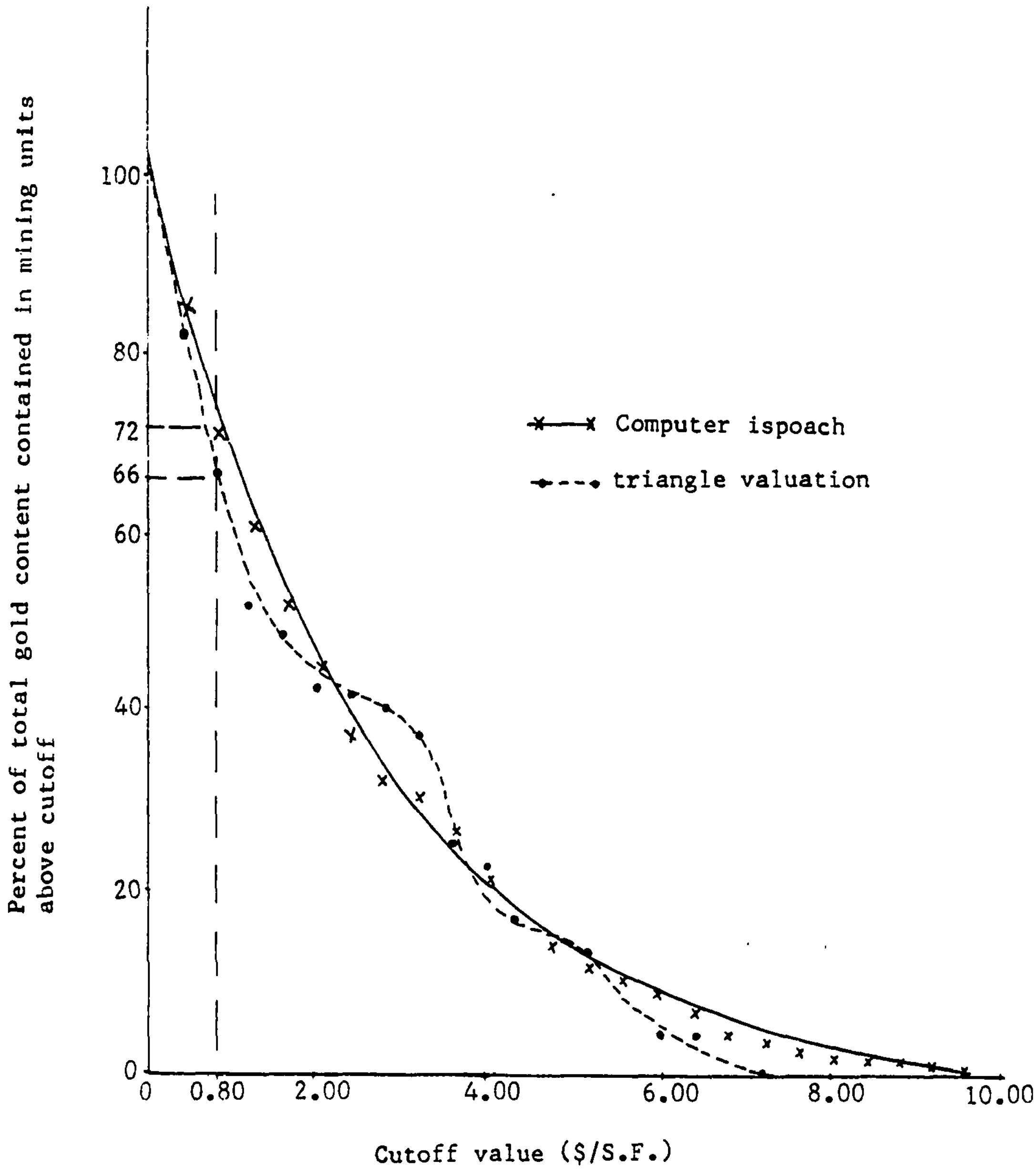


Figure 15. Cutoff grade vs. total gold recovery for block D,G,H, and F.

Triangular techniques indicate only 66% of the total content to be minable above the cutoff value. This difference of six percent translates into several thousand ounces of gold. Very significant differences in the U-G orebody parameters results from this discrepancy. Table 6 presents these differences.

At a $3.00 per square foot cutoff value, a much higher percentage of gold is recoverable as indicated by triangle techniques than is indicated in Figure 15 by isopach valuation. In observing the values of the blocks in relation to the drill holes, the cause for this high concentration is apparent. High values along lines are connected with low values in adjacent lines and this will result in moderate values for the entire block. No minable reserves are indicated above $7.20 S.F. by triangle valuation whereas computer isopach valuation indicates that about 4% of the total gold content is minable at this cutoff. This probably more accurately reflects the existence of small, high-grade tabular bodies.

Table 6 and Figures 16 and 17 present the U-G orebody comparisons isolated from blocks D, G, H and F. Numerically and diagramatically, it is apparent that the representation of the U-G orebody by triangle valuation techniques does not encompass as much surface area as by computer isopach techniques. Further, muck and gravel volumes are undervalued by triangle techniques while the total value of gold within the orebody is lower, but by a smaller magnitude. An explanation for this latter discrepancy can be advanced following an

Table 6. Comparison of results between triangle and computer isopach techniques on the U-G orebody.

		Trinagle	Computer Isopach
Total Surface Area (S.F.)		615,500	907,600
Volume of Gravel (C.Y.)		485,410	765,926
Volume of Muck (C.Y.)		1,866,464	2,815,481
Total Value of Gold (Oz)		40,363	55,099
Ounces Gold Per C.Y. Gravel		0.0831	0.0720
	Reserves	Lower	Higher
	Ore Grade	Higher	Lower

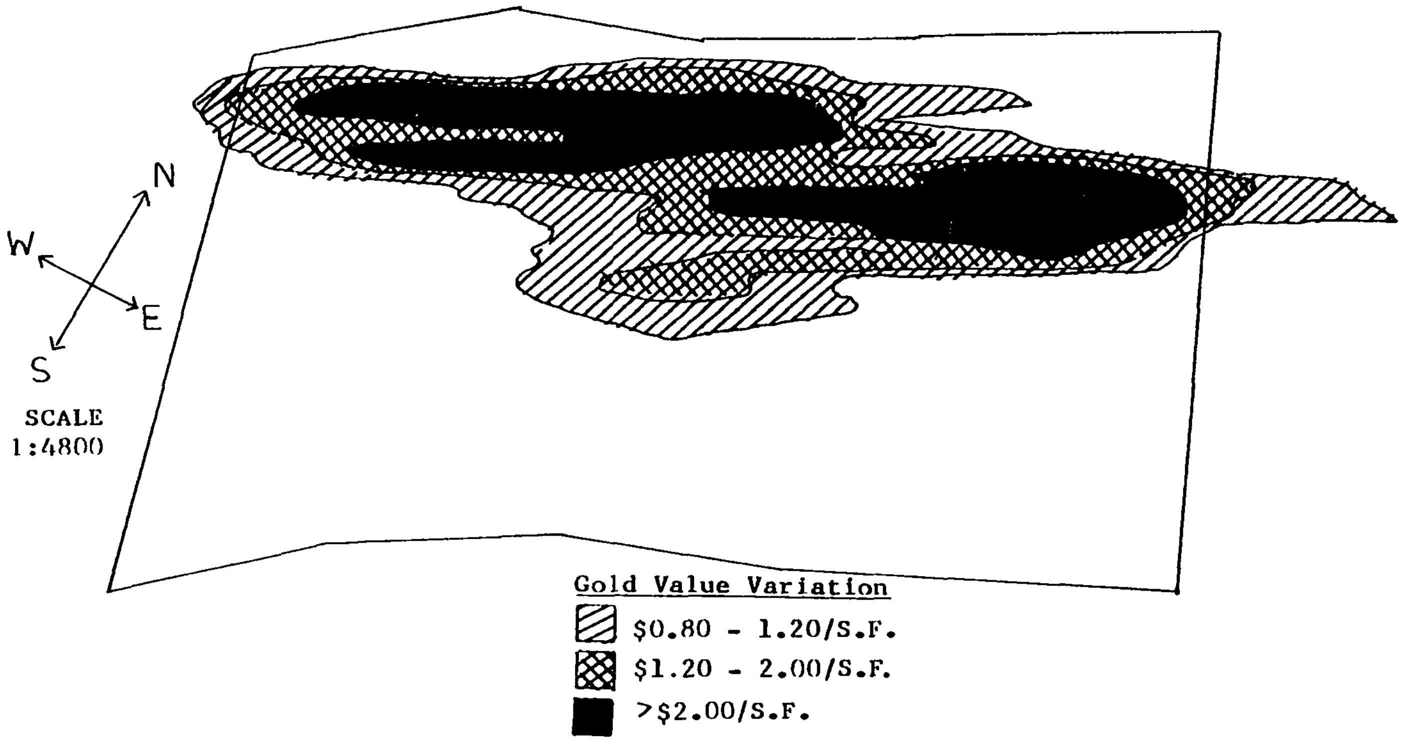


Figure 16. U-G orebody computer isopach valuation.
($/S.F. assuming $35/ounce gold)

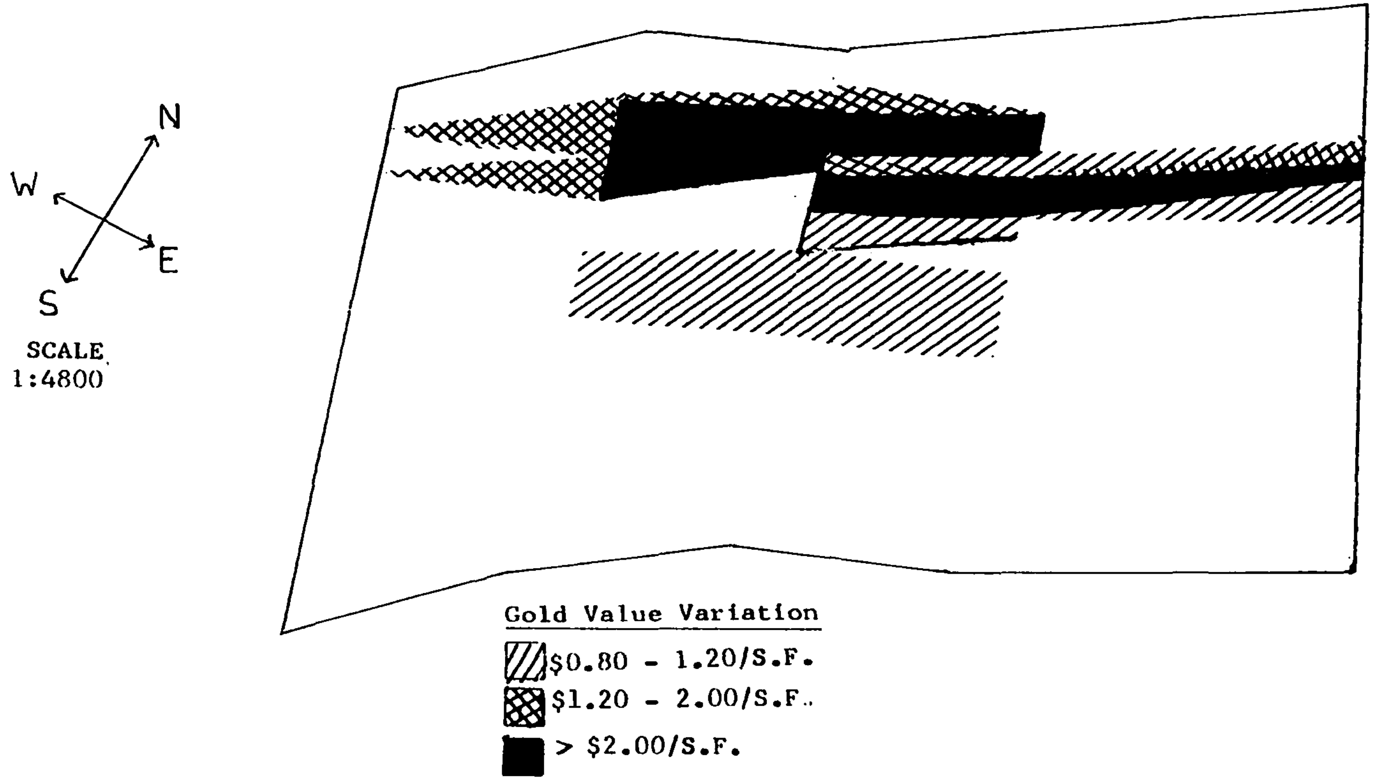


Figure 17. U-G orebody triangle valuation.
($/S.F. assuming $35/ounce gold)

inspection of the relationship of the drill hole values to the triangles above the \$0.80/S.F. cutoff grade. Values much higher than the cutoff grade are seen at drill hole location at many points along the margin of the orebody cutoff zone. Adjacent areas are not, however, recognized as orebody reserves due to a low value at an apex at that triangle. The distance between these high and low drill values is between 250 and 700 feet, the distance between drill lines.

It would be unrealistic to believe that the actual cutoff of the orebody reserves are along drill lines. Furthermore, it should not be expected that a drill-hole value of double the cutoff grade will represent the true limit of the orebody. Most likely there can be a graduation of the average gold values between the lines, and the actual cutoff limit will lie between the drill-lines. The under-representation of the muck and gravel volumes in the orebody is the most apparent result of straight-line cutoff techniques. Also observed in this case is the overvaluation of the average grade of the gravel.

Parker (1977) describes this situation with regard to polygon techniques. The cutoff grade-tonnage distribution to be expected from polygons will usually represent the distribution of the samples themselves. The result will be that high value samples may cause an overestimation of the average grade, whilst the yardage will become underestimated due to the non-inclusion of peripheral ground.

Krige (1978) states that as the reliability of sampling and estimating techniques rise, the volume of minable material will increase, while the value for that material will decrease. This arises because the variance of the sample group is directly related to the lognormal distribution. As the reliability increases, the predicted distribution becomes less erratic.

In the case of the U-G orebody, the cutoff margins not included in the triangle valuation technique will tend to represent gold concentrations near or slightly higher than the cutoff grade of $0.80/S.F. The omission of these areas by valuation techniques will tend to raise the average grade of the reserves. Only the very rich ground is included in the valuation summary, and a higher grade of gravel will be reported. The implications of this are critical. By using straight-line cutoff limits, as is used in the triangle valuation method, a small, richer orebody is defined. This means that less earthmoving is required, a smaller mine and washing plant are needed, and a lower production output is required to maintain a profitable operation. Faster payback times on the capital investments and a higher rate of return on the investment would be reported by feasibility studies prior to the production decision. With the onset of production, the revenue forecasts may not be attained, and the mine may meet with an early retirement.

For the remainder of this thesis, triangle and double-end area valuation techniques are no longer to be considered for reserve estimation within the U-G orebody. The final reserve tabulation and mine plan forecasts represent results derived from computer isopach valuation. These data constitute an important factor in the determination of economic feasibility for an underground placer mine.

Comparisons of Techniques - Qualitative

A powerful feature of computer isopach profiling is the ability of the results to be useful for mine planning. Figures 16 and 17 provide a striking comparison between triangle and contour reserve depictions of the orebody. The U-G orebody is portrayed in the triangle valuation as a haphazard collection of lines, with no apparent relationship between blocks of increasing grade. The results obtained by contour profiling, on the other hand, depict the same deposit as a long tabular body. Lobes of higher average gold values extend parallel to the strike of the creek. Average gold values tend to grade from higher to lower levels in a uniform manner. In reality, it can be expected that there will be high grade zones as portrayed in Figure 16. These may be spotty and actually range from high to extremely low gold values over short distances, however, the zones will probably appear similar to Figure 16. Intuitively and from the cutoff grade analysis it can be stated that the contour profile as shown in Figure 16 is a much better representation of actual gold concentration than the triangle distribution, as shown in Figure 17.

Another feature of computer contour techniques is the ability of the programming to transfer the contour values to a three dimensional block representation of the parameter value. Plates 2, 3 and 4 are perspective block diagrams of overburden thickness variation, gravel thickness, and gold values along bedrock respectively. Perspective diagrams can be prepared in a variety of ways. The deposit can be presented at any angle, with reference to both vertical or horizontal orientation. Different perspectives can be easily programmed into the data to enable the information to be viewed from a narrow to wide angle of view. This type of format is of great value to mine planning and development. In addition, the visual impact of the deposit parameters makes this a very valuable communications tool. This has application in the reporting of data between different management divisions within a company and between a firm and its investment source.

Presentation of Valuation Results For U-G Orebody

The profile of the U-G orebody and an estimation of its value can be determined through the use of computer profile and isopach techniques. To better understand these results, it is important to be aware of the relation of these forecasts to reality. Obviously, assumptions must be made to determine the actual distributions of gold values within the orebody. In order to accomplish this, the gold distribution within the orebody will be compared with the gold distribution in placers and paleoplacers throughout the world.

The greatest amount of research into the gold distribution of placer deposits has been focused on the South African banket ores. The distribution of gold values is positively skewed with the sample mode well to the left of the mean, as plotted in a histogram format. By plotting these skewed histograms on a logarithmic scale, the distribution pattern resembles a normal distribution. For this reason, the distribution pattern of gold placers is termed lognormal (Krige, 1978). Geologically, the Witwatersrand paleoplacers were formed as low angle wet alluvial fans in a fluvial deltaic setting. Normal principles of placer deposition are assumed in this model and the lognormal distribution is a direct result of these placer principles. In areas of reconcentration of fan deposits by stream placers, a high value distribution is observed within the low value distribution, hence a bimodal lognormal distribution (Triiter, 1966).

Sinclair continues the applicability of lognormal distributions further and suggests that many natural densities follow this configuration. These would include minor elements in geochemistry, grades and tonnages of mineral deposits, pH measurements and sediment size data (Sinclair, 1977). In general, most precious metal deposits show a lognormal distribution and are treated accordingly. Many of the Mexican silver mines follow this distribution (Davis, 1973) as do tin placers in Malaysia (Williamson, 1974).

Figure 18 shows the distribution of drill hole values within the U-G orebody. Note that the histogram data is extremely skewed to the right. Figure 19 shows the same histogram in a logarithmic scale. The distribution resembles a normal distribution under this transformation. Clearly, the data suggests that the U-G orebody values have a lognormal distribution.

Figure 20 depicts the cutoff value characteristics with respect to total gold extractable and total gravel minable. The total minable gravel relationship assumes underground development. The steeper slope of this curve reflects the very concentrated nature of the average gold values in the high cutoff zones. This is important in cutoff grade selection. While an increase in the cutoff grade will result in a decrease in ultimate gross revenues of the orebody, it will also result in much lower capital and operating costs, since smaller volumes of gravel will have to be mined.

Figure 21 illustrates the relationship between the cutoff grade and the average grade expected as a result of that cutoff grade. This is a direct linear relationship and an interesting factor is observed between the average grade above cutoff and the equal axis. A constant variation of \$.80/S.F. between these two lines can be noted. In other words, regardless of the cutoff grade, the average grade will be \$.80/S.F. higher than that respective cutoff grade. Results such as these are important in feasibility studies since they help predict the average revenue expected at given cutoff grades and varying production rates.

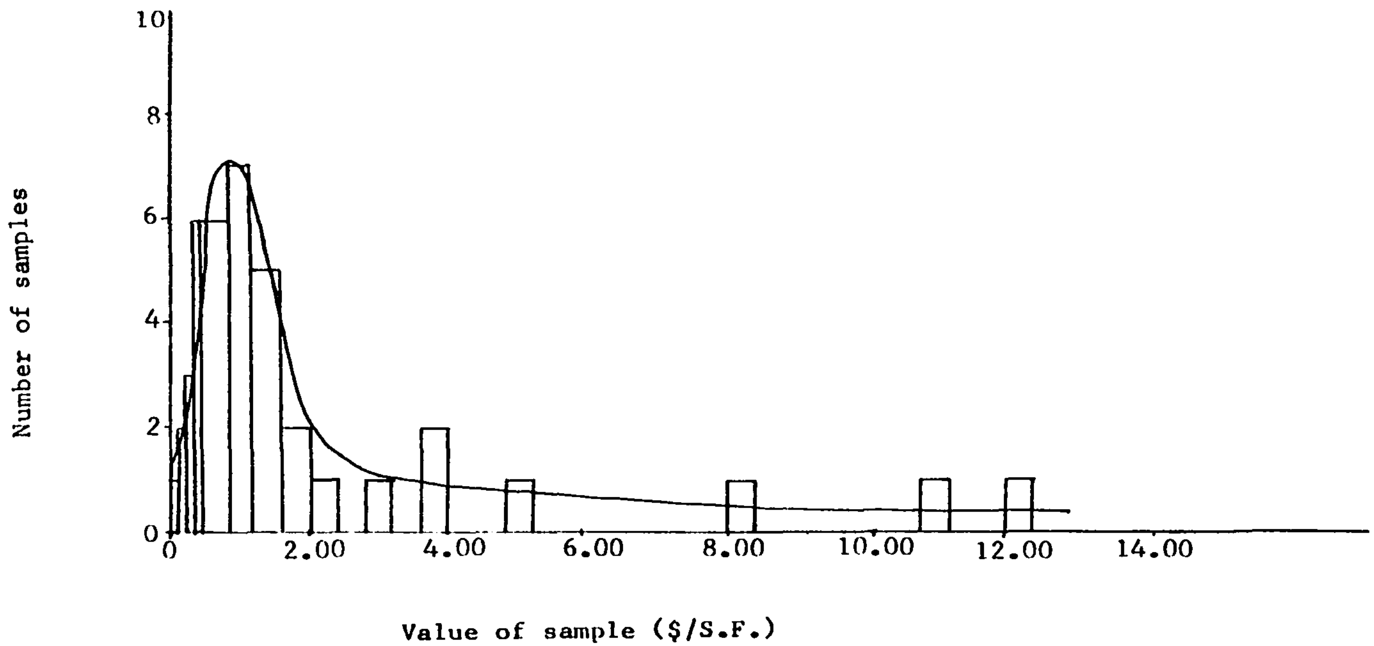


Figure 18. Histogram of drill hole values within the U-G orebody using an arithmetic scale.

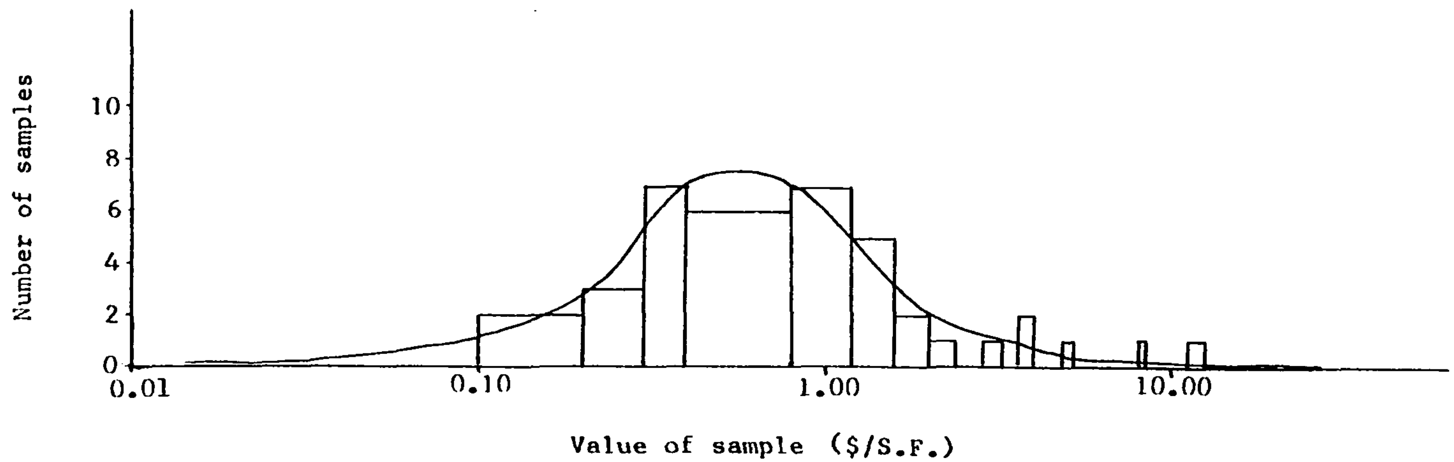


Figure 19. Histogram of drill hole values within the U-G orebody using a logarithmic scale.

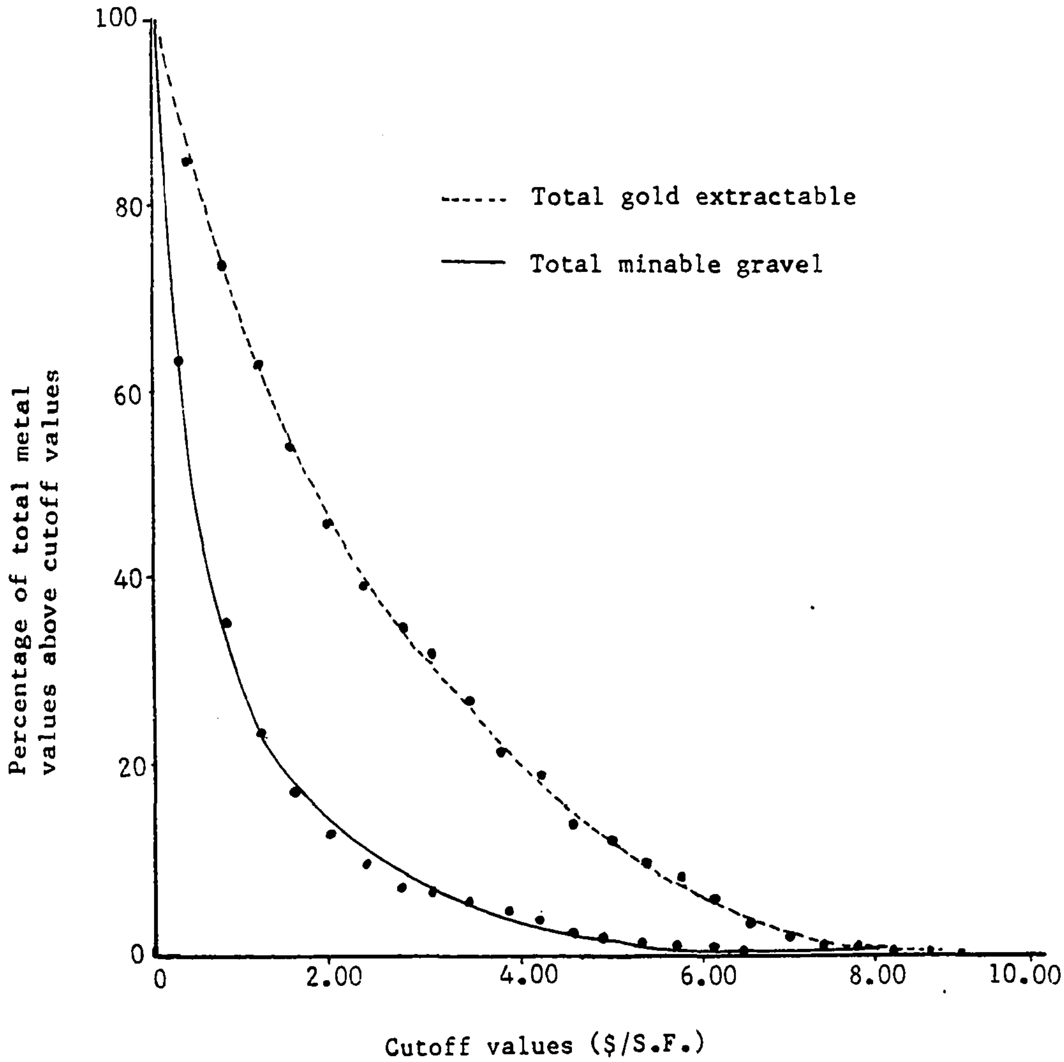


Figure 20. Cutoff grades vs. total metal content extractable and total gravel minable for the U-G orebody.

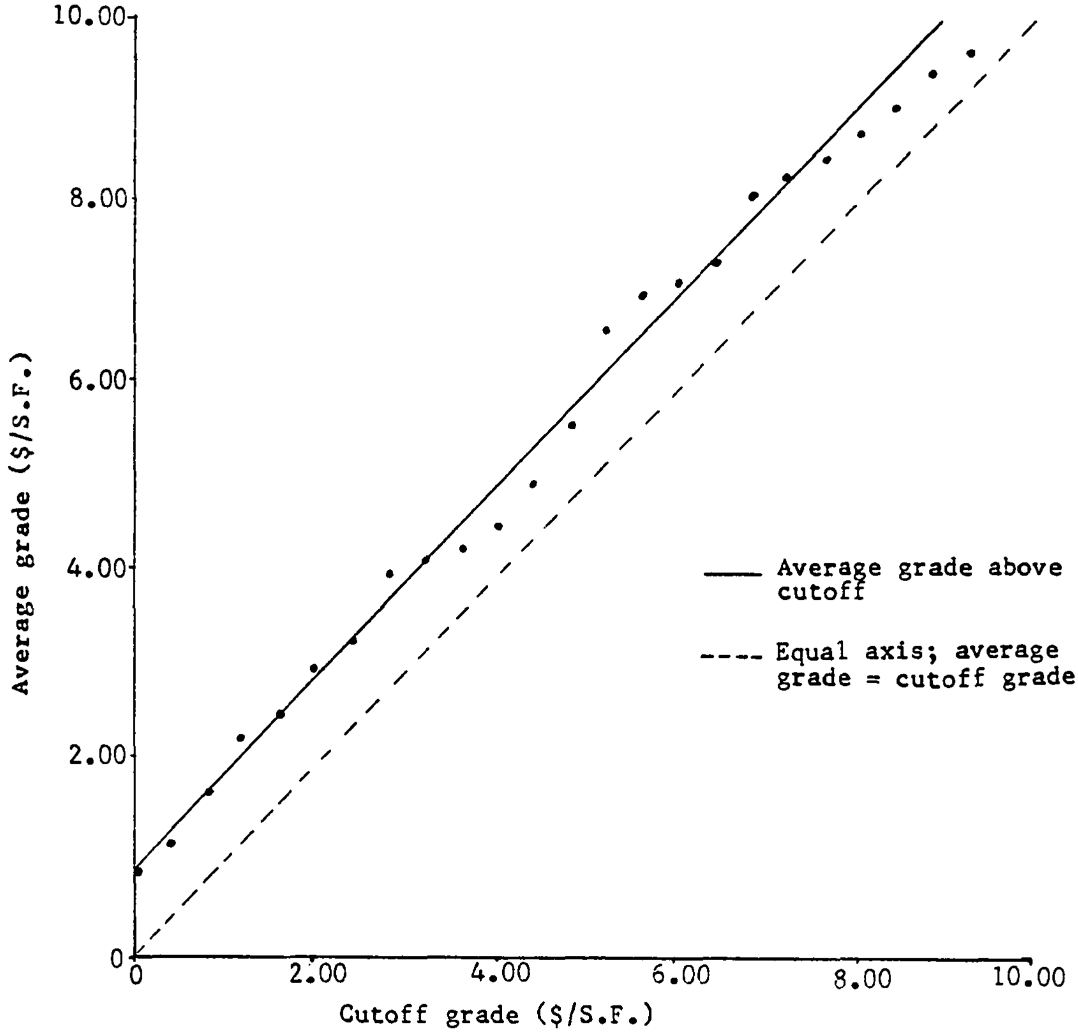


Figure 21. Cutoff grade vs. average grade for the U-G orebody.

Before the tabulated results from computer isopach valuation can be used with confidence, estimation of the error associated with this procedure must be made. Figure 22 presents the data shown in Figure 20 after a long normal-probability transformation has been made. After this transformation, a lognormal distribution should plot as a straight line. In this case, both distributions bend downward at high cutoff grades. This is an indication of one of two factors: truncated data or a mix of two populations (Sinclair, 1977). Since an inflection point is necessary for a bimodal distribution, which is not observed in the data, a two population mix is not suspected. Instead, the second order nature of this curve suggests a top-truncated distribution. (Sinclair, 1977.)

There can be several causes for this top truncated distribution, due to either sampling or geological bias. The top-truncated nature suggests that there is an under-representation of high-value ground. In the original drilling, high-value holes may have been down-graded for fear of overestimating reserves. The placer deposit may be naturally top-truncated and deviate from the lognormal at high gold concentrations in the gravel. Another cause may be that several holes in the high-grade gravel had intersected old drift working and were reported as low-grade holes.

Finally, the top-truncated nature of the final results may reflect the conservative nature of the evaluation technique itself. Earlier, in Figure 4, it was shown that at high drill hole values,

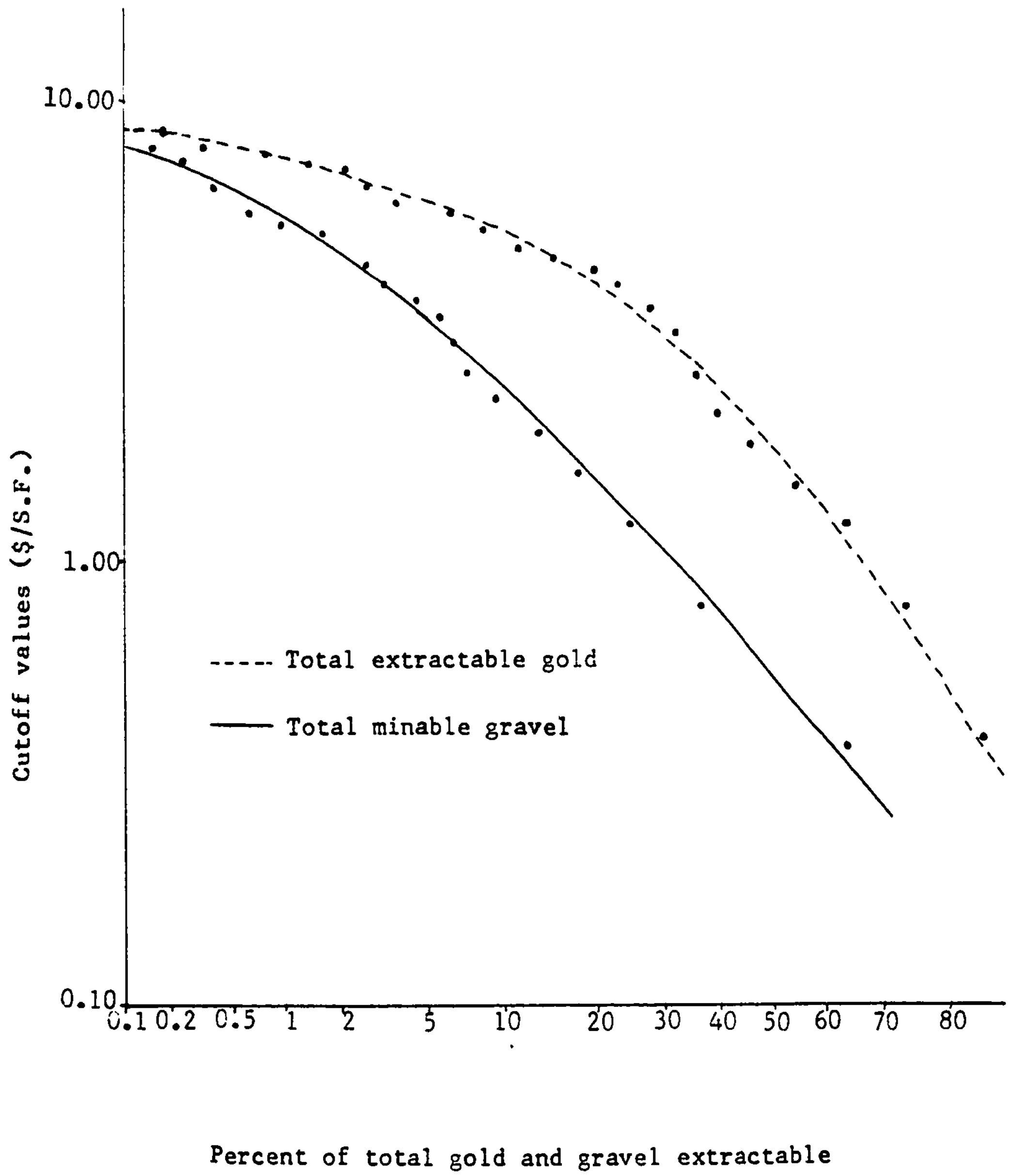


Figure 22. Cumulative lognormal distribution of total gold content extractable and total minable gravel at each cutoff grade.

the estimated values became progressively lower than the observed drill-hole values. This is a deliberate truncation of high-value data in order to avoid overestimation of reserves. In order to be consistent, no effort to upgrade the reserves should be made. This error of estimation should encompass most of the sixteen percent absolute error between actual and predicted sample values and cause the estimated reserves to be lower than the actual reserves, which is desired.

In conclusion, a final reserve tableau can be presented. Underground mining of the 8.5 foot section of most payable material is assumed. Within this section, 90% of the total gold values in the gravel section is considered extractable. (Green and Thomas, personal communication, 1980.) This can be tabulated in the following form.

Total Gold Content (Table 4ii)	55,099 oz.
Total Surface Area (Table 4ii)	907,600 S.F.
Mine Face Height	8.5 ft.
Total Volume	285,725 C.Y.
Total Gold Content Extractable (55099 x 0.90)	49,589 oz.
Average Value of Ore	0.174 oz./C.Y.

Valuation Summary

Prior to the feasibility study of any mining project, an accurate forecast must be made of the reserves. The deposit must be drilled and sampled on a systematic basis and a procedure developed to evaluate the exploration data. The objectives of this phase of the work are twofold. Firstly, to differentiate between payable and unpayable placer ground in order to develop a mine plan and secondly, to accurately evaluate the reserves within the payable ground and express them in terms of grade and tonnage.

A computer modeling technique was used to fulfill these two goals of the valuation process. The conventional techniques of block and triangle valuation are compared and contrasted with computer techniques. The U-G orebody was delineated and distribution and cutoff grade analysis was performed. The use of these techniques was important in evaluating the orebody. Calculations of the average grades and total reserves at various cutoffs provide a flexible basis for mine planning.

Sources of error within the computer modeling technique were examined by several methods, including residual curves and probability functions. This allowed a determination of whether the reserve error was due to undervaluing or overvaluing the deposit. Grade and yardage, assuming an underground mining plan for the U-G orebody, are presented and used in the feasibility study of the project. These values are as follows: an assumed mine face 8.5 feet high;

49,589 troy ounces of gold extractable in 285,725 cubic yards; and average value of the ore is 0.174 ounces per cubic yard. All error and distribution analyses suggest that this is a conservative estimate.

FEASIBILITY

Mine Plan and Procedure

Mining Cycle

The mining plan employed for exploitation of the U-G orebody is a conventional drill-blast-muck cycle. Whenever possible, the mining plan will relate to known mining techniques and known properties of the gravel. It is not the purpose of this feasibility study to introduce a new mining technique, only to use existing mining methods on a new type of mine plan.

Surface mining by open-cut is the alternative to mining underground. Although surface excavation is much more understood and amenable to mine operators, very significant environmental barriers exist which are not as important in underground mining. These include silt and clay runoffs into local watersheds and surface restoration.

Several methods have been proposed to deal with the problem of underground placer mining. These include continuous miners, rock and tunnel borers, localized steam thawing, in addition to exotic, esoteric techniques such as microwave thawing and ripping. Russian underground mining experience and U.S. research all suggest that drilling and blasting, while possibly not the most economic method in the long run, is technically feasible for frozen gravel extraction. As a matter of fact, drill-blast techniques were used on

Little Eldorado Creek in the Fairbanks District in the mid-1920's. Jack-hammer drills, slushers, and explosives were utilized as opposed to conventional steam-thawing techniques. By this method, 350 square feet of bedrock were cleaned per shift. (Wimmler, 1927.) The undulating-bedrock profile for which Livengood Creek is noted suggests the use of a drill-blast cycle. The versatility of this technique would be more suitable for varying slope conditions.

Breast-stoping techniques on a retreat basis have been used successfully in Alaska and the Yukon in the past (Peele, 1941) and are presently employed in Russia (Potiokin, 1960). In Russia, haulage development is driven parallel to the axis of the paystreak. This is carried out to the limits of the deposit. Ore extraction is then carried out using retreat-stoping methods, advancing toward the mine entry. The stopes are allowed to subside upon retreat and at no time are the ore passages and manways threatened by this subsidiance (Potiokin, 1960). At the U.S. Bureau of Mines test site in Fox, Alaska, a 21.3 x 9.1 meter room is considered stable and safe even though without artificial roof support for over a decade (Pettibone, 1971). In Russia, pillars are left in some instances when the uncovered surface of the mined-out area exceeds 64,000 square feet (Potiomkin, 1960). In the case of unexpected slabbing conditions in the U-G orebody, an allowance for pillar support is provided. Experience may dictate the use of other procedures such as tailings or ice backfill to minimize subsidiance.

Two small percussion jumbo drills are employed in the mining cycle. U.S. Bureau of Mines data from research at Fox, Alaska suggests a drilling rate of 3-5 feet per minute in frozen gravel using an air-leg mounted drill (Dick, 1973). Problems were encountered when the drill cuttings refroze in the bore hole. Antifreeze drilling fluids or the use of compressed air have been suggested as a means to combat this problem. Given the rate of drilling from the Bureau of Mines, a 40 foot by 8.5 foot face will require less than three hours of drilling using multiple burn-cut methods. V-cut methods have been found to be inadequate with regard to the length of the muck pile and sizing of the blasted material when compared to burn-cut techniques (Dick, 1973).

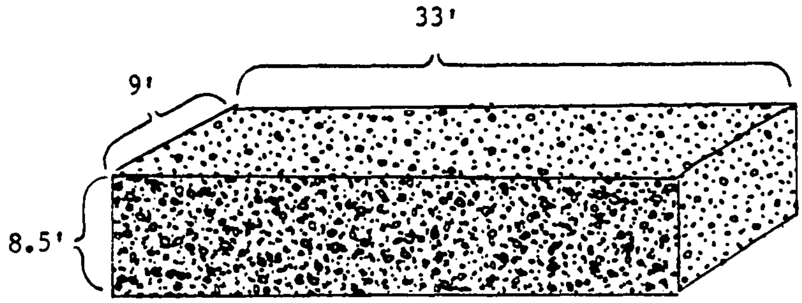
The type of explosives is not considered to be a significant parameter in blasting frozen gravel (Dick, 1973). For this reason, in addition to its low cost, ANFO is used. 0.136 lbs of explosives per cubic foot of gravel removed is required to adequately blast the material (Dick, 1973). The ANFO will be loaded in the holes with a small air-pump system.

After the material has been blasted, 5-yard diesel load-haul-dump (L-H-D) units will muck the broken material and tram it to a high room into 35-ton low-profile trucks. A maximum economic tramming distance of 900 feet (Hoppe, 1978) by the L-H-D units must be considered in the planning of the loading area. Two L-H-D units will be tramming ore and two low-profile trucks will convey this material to the surface. In order to minimize waiting time for the L-H-D units, a surge hopper in a raised room will be provided. As the low profile trucks dump the ore at the surface, a front-end loader will prepare the material for winter storage.

Figure 23 shows the production parameters which are assumed during stoping operations. To insure that these production goals can be met, the cycle times for the L-H-D units and low profile trucks must be estimated. Table 7 lists these calculations. To meet the planned production goals, assuming downtime for maintenance and imperfect operators efficiency, two L-H-D units and two low-profile trucks will be required. Operator efficiences required for the L-H-D units and trucks are 88% and 77% respectively. This is assuming normal operating conditions; trained employees should be able to meet these guidelines without difficulty.

It is not practical, or even possible, to wash the auriferous gravel in the winter. In the past, the frozen gravel was hoisted by self-dumping bucket, which traveled up a cable to a gin-pole and deposited in a conical pile above a sluice box. During early summer, the gravels were hydraulically washed into the boxes. (Wimmler, 1927.) For the U-G orebody, the frozen gravels will be conveyed to a washing plant with the front-end loader and sluiced during the summer months.

The gravels at Livengood are characterized by high clay contents (lightwood, personal communication, 1980). To alleviate any



Size of mining face

$3400\ ft^3$ per face = $126\ yd^3$ per face
Swell factor = 1.77 (Dick, 1973)
2 faces per shift
2 shifts per day or 4 faces per day
3000 lbs per cubic yard

Production parameters

	Per face		Per day	
	Yardage	Tonnage	Yardage	Tonnage
Unbroken	95	142.5	380	570
Broken	168	142.5	672	570

Figure 23. Assumed production parameters for the stoping cycle.

Table 7. Cycle time analysis for L-H-D units and low profile trucks

L-H-D Units

5 C.Y. per cycle - broken material

9.2 minute per cycle (Joy, phone quote, 1980)

At 900' tram

15 minutes per hour maintenance (International Harvester)

428 C.Y. per shift - 2 units

8.75 hours per shift required per unit

88% operator efficiency required to meet production goals

Low-Profile Trucks

20 C.Y. (Heaped) per cycle - broken material

35.75 minutes per cycle (D.L.P. Specifications, 1980) from loader to surface

10 minutes per hour maintenance (International Harvester)

428 C.Y. per shift - 2 units

7.65 hours per shift required per truck

77% operator efficiency required to meet production goals problems, the wash plant will employ a trommel feeding into sluice boxes. This is similar to the system used on Porcupine Creek in the Circle District (Haskins, 1979) and should break up the clay to prevent packing. Primary gold cleanup would employ long-toms while secondary black sands recovery would employ a shaking table,clean-up wheel, or a similar device.

Ventilation and Support Systems

Ventilation systems and support procedures are critical factors which must be considered in the feasibility study. The ventilation systems must account for large releases of dust and explosive gases at the mine faces and accumulations of carbon monoxide in the haulage ways from the use of diesel equipment. The support system must allow for the safety of the underground miners and reduce the release of dust caused by sublimation of the mine faces.

The ventilation system used in the U-G mine will be similar to those employed in the northeastern part of Russia. Small shafts or boreholes are driven every 65-75 feet along the border of the ore zone. This allows for an inflow of air at the working face and facilitates the removal of dust produced from drilling and gases from the explosive charges (Potiomkin, 1960). A secondary shaft located at the end of the main haulageway permits a large intake of air. This air flow assists in the ventilation of the haulage way and working faces. A large dual-system fan in the main shaft provides the air exhaust. This system is depicted in Figure 24.

An additional air intake will be located at the mine portal. This will provide for a removal of the noxious diesel fumes produced by the fully-loaded low-profile trucks traveling up the incline. A series of airlocks and airflow regulators within the mine will permit control of the air-flow passages. A single fan will be used during normal working conditions. Blasting will take place at the end of each shift. At that time, both fans will be employed to allow for explosive gas removal. The fan system is designed to meet worst case conditions, that of a methane rich, "gassy" coal mine. In actuality, a smaller system may be feasible.

In addition to ventilation, support of the underground workings is a critical factor. Support problems can be classified into two types, rockfall and large scale slabbing and deformation. The first, rockfall, results from the sublimation of ice at the rock faces. Recent research suggests that sublimation on an unattended face of frozen overburden occurs at a rate of between 0.001 to 0.006 inches a day. (Wellen, 1979.) If sublimation is allowed to continue at this rate, two problems will be observed. The first is a buildup of dust along the walls which will add to the ventilation problems. Secondly, sublimation of the surface layer will result in a dislodging of surface rocks. Accompanying rockfall would be a safety hazard.

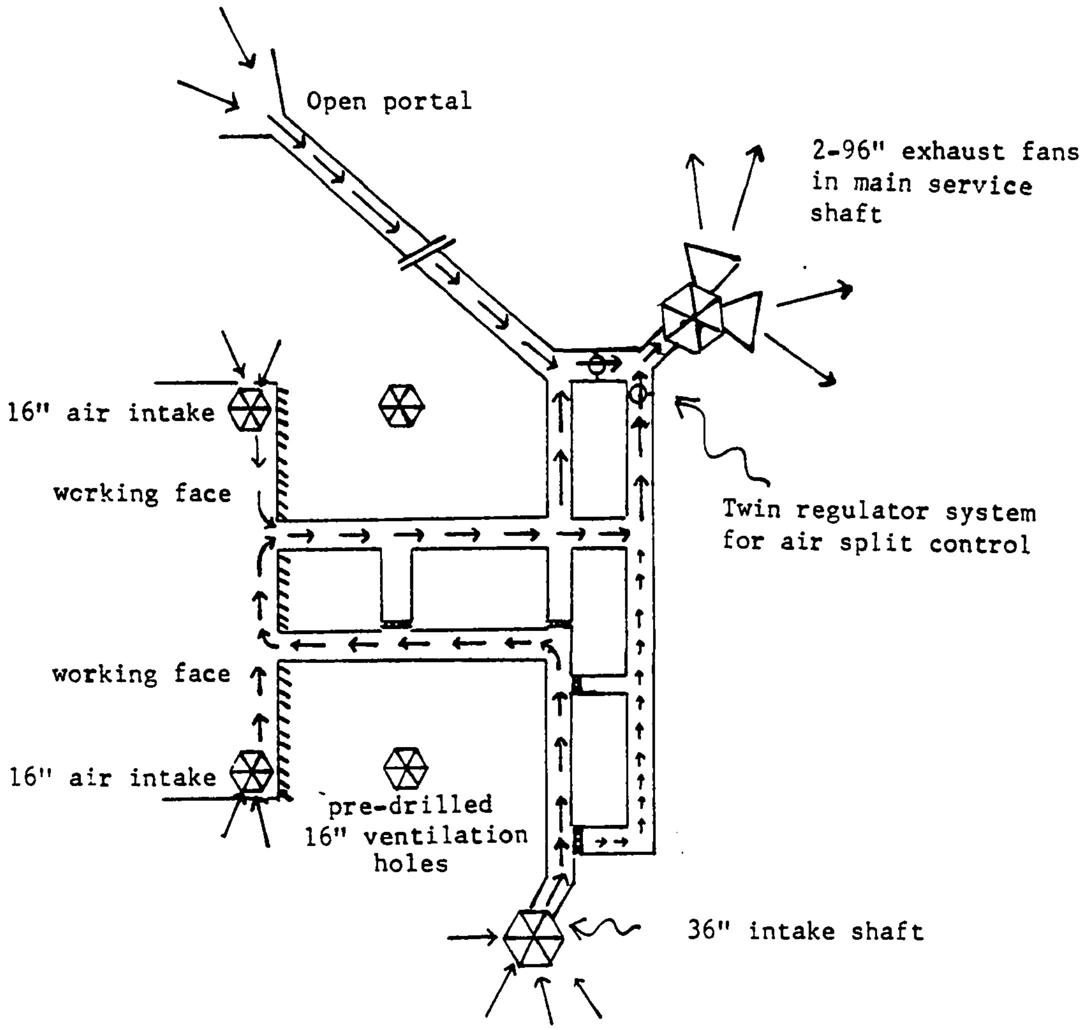


Figure 24. Flow diagram of ventilation system.

In Greenland, a low-cost method to attend to this problem has been developed. A mixture of cold water and rock-flour slurry is sprayed on the rock face. This prevents the sublimation of the rock face and actually hardens the surface. Permacrete is the term applied for this procedure. It has been shown that permacrete is stronger and much cheaper than Portland cement in winter conditions (Swinsow, 1964).

A thin spray of permacrete produces an ice layer of one quarter inch thickness. Ice from this spray penetrates up to one-half inch into the pores of the wall rock (Swinsow, 1964). This is found to be sufficient for most working conditions. In the over-burden incline, the support will be steel lining backfilled with permacrete. Where the incline passes the arctic surface permafrost layer, backfilling will utilize cement. An ice thickness of over 4 inches will provide for safe working conditions in both the incline and along the ore passages. In all cases, the permacrete face must be recoated periodically to check any sublimation which may occur.

Large scale slabbing and deformation cannot be controlled by permacrete spraying; these must be prevented by proper mining procedures. As discussed earlier, pillars will be left as necessary for safe working conditions. Since almost instantaneous grading of the gravel is possible by panning, these pillars can be selectively chosen to employ only low-grade gravels within the paystreak.

In the Tuto area, experiments were conducted utilizing permacrete to construct pillars in unstable zones (Swinsow, 1964). These permacrete columns will help reduce pillar loss. As an additional support technique, ammonia heat pumps can be used in the predrilled air boreholes. This will further reduce thawing of the gravels prior to stoping.

The ventilation system will aid in stabilizing all gravel faces. During between-shift venting, the surfaces will be supercooled by the passing winter air. During the shifts, the air temperature will rise somewhat due to the natural heat stored in the permafrost gravel and by the working machinery. Whilst there is a lack of evidence to support this, working temperatures in the mine should be above 0°F and below freezing. Wind chill may present a problem during between-shift venting, although personnel would not be spending more then limited time underground during these periods. During shift time, wind chill problems can be minimized by using only one fan for ventilation. All cabs will be heated and enclosed to provide for the comfort of the operators.

Air temperature is the major constraint on winter operations. If the temperature of the ventilated air raises above the freezing level, ventilation will not aid support but instead would cause major concern for the stability of the underground development (Pettibone, 1971). Summer operations would require extensive timbering and refrigeration systems at prohibitive cost.

Planned Production Schedule

Prior to production stoping within the U-G orebody, two years of production work will be required. The first year will be comprised primarily of engineering and feasibility studies. Detailed mine requirements and a comprehensive mining plan layout will result from this work. In the summer of the second year, cut and fill development of the inclined haulage ramp will proceed. This will provide ramp access through the most unstable part of the permafrost, the active surface layer. The main shaft and the secondary ventilation shaft will be drilled late in the season and during the winter by large diameter augers. During the final phase of preproduction, in the winter of the second year, the main crosscut development haulage will be constructed. All equipment and surface facilities will be acquired and readied during this second year.

Production will formally commence in the third year with the construction of strike haulage and stope development. Since all development is within the minable gravels, revenues will be realized at this time. Therefore, production royalties and tax obligations also start during this year. The U-G orebody will be mined in the following four years employing retreat breast-stoping techniques. In summary, the planning schedule of the mining operation will appear as follows:

Year zero: Initial property payment

Feasibility and Engineering

Year one: Plant and equipment acquisition

Preproduction development

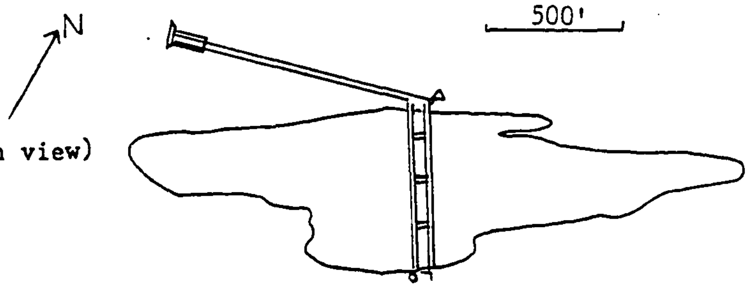
Year two: Production development

Year three to six: Production stoping

The development and stoping plans for years one through six are displayed in Figures 25-30. In addition, revenue forecasts at various gold prices are calculated and tabulated. It must be noted that the average gold value per yard will vary in each stoping block. By employing the gold value variation maps from the property valuation study, the average gold value per yard can be calculated for each block. These expected gross revenues are summarized on Table 8.

Capital Cost Requirements

In order to mine underground by retreat breast-stoping methods, a variety of support and mining equipment is required to assure continuous underground production during the winter months. Appendix F gives a detailed list of the required capital costs needed for the entire operation. This not only includes the underground and surface mining equipment, but also support and living facilities, mine development and required working capital. In addition to this,



Year 1 - Production Development

9700 yd^3 gravel @ 0.174 oz/yd^3

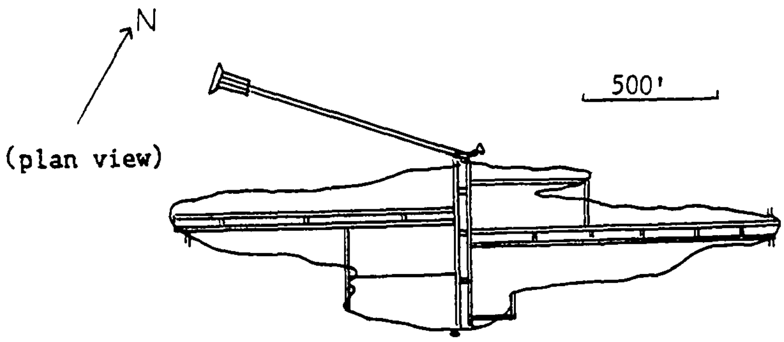
Au = 1687 oz x 0.915 fineness
= 1543 oz gold

Ag = 1687 oz x (1 - 0.915 fineness)
= 143 oz silver

1. Deductions
   2% Smelter fee
2. Assume $20/oz silver in all cases

Price per ounce gold	Credit to development ($)
$450	683,265
$550	834,479
$600	911,020
$625	948,979
$650	985,693
$750	1,136,907
$1000	1,514,942

Figure 25. Production and credit parameters for year one.



Year 2 - Stope Development

43,040 yd^3 @ 0.174 oz/yd^3

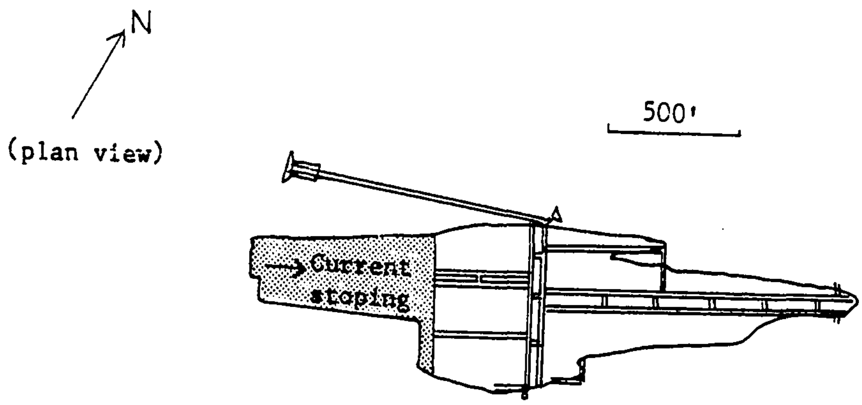
Au = 7488 oz x 0.915 fineness
= 6851 oz gold

Ag = 7488 oz x (1 - 0.915 fineness)
= 635 oz silver

1. Deductions
   2% Smelter fee
2. Assume $20/oz silver in all cases

Price per ounce gold	Gross revenue ($)
$450	3,064,093
$550	3,742,942
$600	4,086,257
$625	4,256,518
$650	4,421,191
$750	5,099,440
$1000	6,873,573

Figure 26. Production and revenue parameters for year two.



Year 3 - Production Stoping

64,800 yd^3 gravel @ 0.176 oz/yd^3

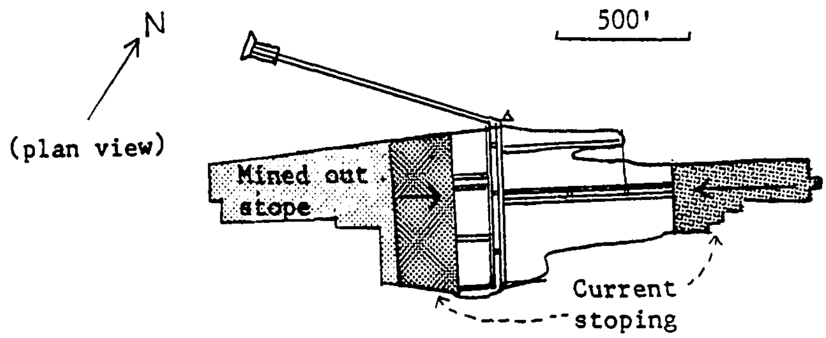
Au = 10,172 oz x 0.915 fineness x 0.95 pillar loss = 8842 oz gold

Ag = 10,172 oz x (1 - 0.915 fineness) x 0.95 pillar loss = 821 oz silver

1. Deductions
   2% Smelter fee
2. Assume $20/oz silver in all cases

Price per ounce gold	Gross revenue ($)
$450	3,955,366
$550	4,879,355
$600	5,270,821
$625	5,493,563
$650	5,706,082
$750	6,581,440
$1000	8,769,835

Figure 27. Production and revenue parameters for year three.



<u>Year 4 - Production Stoping</u>

57,120 yd^3 @ 0.163 oz/yd^3

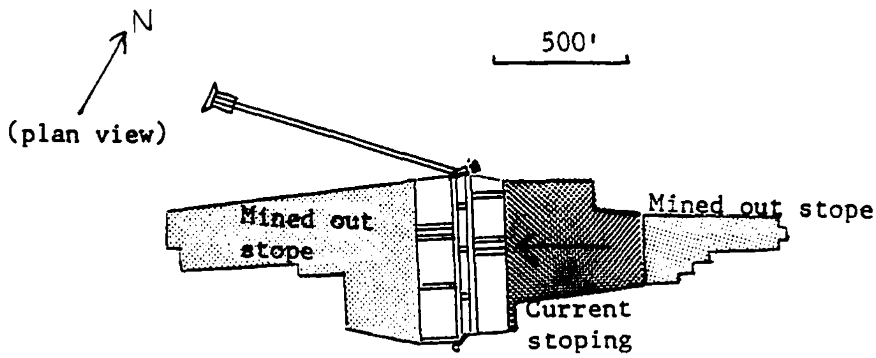
Au = 9311 oz x 0.915 fineness x 0.95 pillar loss = 8093 oz gold

Ag = 9311 oz x (1 - 0.915 fineness) x 0.95 pillar loss = 751 oz silver

1. Deductions
   2% Smelter fee
2. Assume $20/oz silver in all cases

Price per ounce of gold	Gross revenue ($)
$450	3,656,719
$550	4,466,019
$600	4,875,625
$625	5,078,776
$650	5,275,319
$750	6,084,619
$1000	8,107,869

Figure 28. Production and revenue parameters for year four.



Year 5 - Production Stoping

58,300 yd^3 @ 0.182 oz/yd^3

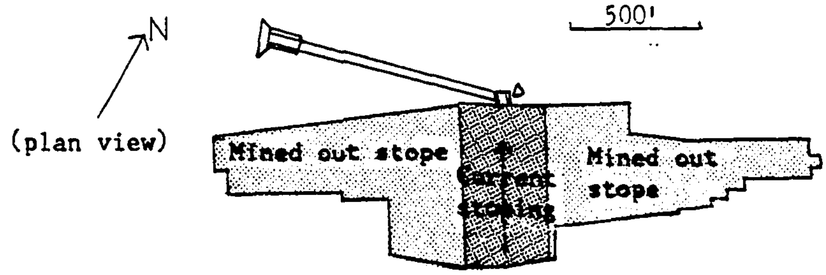
Au = 10,610 oz x 0.915
pillar loss = 9222 oz gold

Ag = 10,610 oz x (1 - 0.915 fineness)
x 0.95 pillar loss = 856 oz silver

1. Deductions
   2% Smelter fee
2. Assume $20/oz silver for all cases

Price per ounce gold	Gross revenue ($)
$450	4,166,348
$550	5,089,048
$600	5,555,797
$625	5,787,288
$650	6,011,248
$750	6,933,448
$1000	9,238,948

Figure 29. Production and revenue parameters for year five.



Year 6 - Production Stoping - Retreat

52,800 yd^3 @ 0.175 oz/yd^3

Au = 9240 oz x 0.915 fineness x 0.95 pillar loss = 8032 oz gold

Ag = 9240 oz x (1 - 0.915 fineness) x 0.95 pillar loss = 746 oz silver

1. Deductions
   2% Smelter fee
2. Assume $20/oz silver in all cases

Price per ounce gold	Gross revenue ($)
$450	3,629,170
$550	4,432,370
$600	4,838,893
$625	5,040,513
$650	5,235,570
$750	6,038,770
$1000	8,046,770

Figure 30. Production and revenue parameters for year six.

Table 8. Summary of expected gross revenues during production development and stoping at various gold prices (1000's dollars).

Gold Price ($/oz.)	Years 2	3	4	5	6
450	3065	3955	3657	4167	3629
550	3743	4879	4466	5089	4432
600	4086	5270	4876	5556	4839
625	4257	5494	5079	5787	5041
650	4421	5706	5275	6011	5236
750	5099	6581	6085	6933	6039
1000	6874	8770	8108	9239	8047

interest will be charged on these monies made available for preproduction development and equipment acquisition. The property acquisition, engineering, development and feasibility studies will be charged to year zero. The remainder of the capital costs including working capital will be incurred during year one.

The total capital investment required for the U-G orebody, including a 15% contingency factor for unforeseen circumstances and cost overruns, is $6,111,367. The total capital requirements are summarized in Table 9. The capital requirements are equivalent to $22.73 per yard of reserves within the U-G orebody.

Estimated Operating Costs Incurred

The operating costs involved in the mining of the U-G orebody can be broken down into those associated with summer and with winter operations, each of six months duration. During the winter, a majority of the costs are accrued as direct mining charges. The summer costs will be primarily due to washing of the gravel, cleaning of the concentrate, and overhaul maintenance on the equipment.

Furthermore, as in any mining operation, the operating costs can be broken down into direct, indirect, and fixed costs. Direct costs include operating, supervisory and maintenance labor, overhead on that labor, operating and maintenance supplies and power and water. Indirect costs include administrative, technical, and clerical payroll and its overhead, and general administrative overhead. The

Table 9. Total capital requirements (dollars)

Surface Plant & Building	1,135,050
Underground Plant & Equipment	1,862,532
Property Acquisition	35,000
Exploration, Development and Feasibility Studies	200,000
Mine Development	711,097
Support Facilities	535,900
Total Plant Cost (for insurance, tax base)	4,479,570
Interest During Winter Construction (5%)	233,978
Subtotal for Depreciation	4,703,549
Working Capital (3 months-winter)	1,407,818
Total Capital Investment	6,111,367

fixed costs include insurance and property taxes. These fixed costs will be incurred at all levels of production.

Appendix G lists the operating costs in detail for the production years. General manning tables for the summer and winter seasons, operating and maintenance supplies and power and water costs are tabulated and calculated. Tables 10 and 11 summarize these detailed summer and winter operating costs respectively. Table 12 summarizes the total annual operating costs involved in mining and support operations. Finally, Table 13 tabulates the total operating cost in terms of costs per yard of gravel mined and washed. The total annual operating costs are $2,956.769. This equates to an average production cost of $50.78 per yard of gravel mined and washed.

Taxes, Financing, and Cash Flow Assumptions

Prior to estimating annual cash flow to be expected from the mining of the U-G orebody, certain assumptions must be made regarding the taxes incurred, the depreciation method, royalty, and the choices allowed for depletion of the orebody. In addition to this, financing techniques to be employed should be considered in order to determine the profitability of the operation in terms of repayment of the original investment.

In Alaska, an incorporated mining operation would be subject to four types of tax. These include federal and state corporate

Table 10. Estimated summer operating cost (dollars).

Item	Mine Cost	Support Cost	Total Cost
Direct Cost			
Operating Labor	43,374	-	43,374
Supervisory Labor	7,680	11,520	19,200
Maintenance Labor	-	151,114	151,114
Operating & Maintenance Supply	39,225	68,442	207,667
Power & Water	1,991	1,097	3,088
Payroll Overhead at 35%	17,868	56,921	74,790
Total Direct Cost	110,138	289,094	399,233
Indirect Cost			
Administrative, Technical, Clerical	14,400	14,400	28,800
Payroll Overhead	5,040	5,040	10,080
General Overhead (5% of direct)	5,507	14,354	19,861
Total Indirect Cost	24,947	33,794	58,741
Fixed Cost			
Taxes & Insurance (1% of Plant)	32,748	11,916	44,664
Property Taxes (0.5% of Plant)	15,874	5,958	22,832
Total Fixed Cost	48,622	17,874	67,496
Total Operating Cost	183,707	340,762	524,469

Table 11. Estimated winter operating cost (dollars).

Item	Mine Cost	Support Cost	Total Cost
Direct Cost			
Operating Labor	458,150		458,150
Supervisory Labor	70,840		70,840
Maintenance Labor	87,810	239,551	327,361
Operating & Maintenance Supply	690,978	226,993	917,971
Power & Water	51,977	10,183	62,160
Payroll Overhead 35% Payroll	215,880	83,842	299,722
Total Direct Cost	1,575,657	560,547	2,136,200
Indirect Cost			
Administrative, Technical, Clerical	45,479	45,479	90,959
Payroll Overhead	15,917	15,917	31,835
General Overhead (5% of Direct costs)	78,781	28,027	106,810
Total Indirect Cost	140,177	89,423	229,602
Fixed Costs			
Taxes & Insurance, 1.0% of Plant	32,748	11,916	44,664
Property Taxes, 0.5% of Plant	15,874	5,958	22,832
Total Fixed Costs	48,622	17,874	67,496
Total Operating Costs	1,764,456	667,844	2,432,300

Table 12. Total annual operating costs involved in the mining and washing of the U-G orebody gravels (1000's dollars).

Item	Mine Cost	Support Cost	Total Cost
Direct Cost	1686	848	2535
Indirect Cost	165	123	288
Fixed Cost	97	36	133
Total Operating Cost	1948	1008	2956

Table 13. Average operating costs per cubic yard of gravel mined and washed, dollars.

Average annual production stoping = 58225 cubic yards.

Item	Mine Cost	Support Cost	Total Cost
Direct Cost	28.95	14.59	43.54
Indirect Cost	2.84	2.12	4.96
Fixed Cost	1.67	0.62	2.28
Total Operating Costs	33.46	17.32	50.78

income tax, a state mining license tax, and borough property taxes. Livengood is in an unorganized borough. A tax rate of 1% of the plant value will be applied. This can be considered a fixed operating cost and will not be applied in the cash-flow calculations. The corporate income tax is fixed at 46% of net profit after depreciation and the state tax is 16% of this. Therefore, corporate income taxes will total 54% of the net profit. The state mining license tax, unique to Alaska, is set at $1500 plus 5% of net profit over $50,000, for net profits between $50,000 and $100,000. For net incomes over $100,000, the tax rate is $4000 plus 7% of net income over $100,000. This is calculated from the same net profit as state and federal income taxes. No license taxes are accrued in the first three years of production.

Before the taxes can be applied to net income, the mine operator is allowed to deduct depreciation of the mine plant and depletion of the orebody reserves. There are several methods to calculate both deductions, but here a standard method will be used. The entire plant and equipment inventory required to mine the U-G orebody, listed in Appendix F, will be assumed to have a lift of six years with zero salvage value. Straight line-depreciation methods will be employed. This is equivalent to an annual depreciation allowance of $940,708.

In many operations, the mine owner and mine operator are independent entities. The mine operator must compensate the mine owner's reserves. In many cases this compensation takes the form of an initial cash payment followed by a percentage royalty of net income from the start of production. An initial binder payment at year zero of $35,000 is assumed followed by a production royalty of 7% of net income, before depreciation and depletion deductions. Although this rate is much lower than many placer arrangements, it is close to royalties received for hardrock mining operations. This reflects upon the risky nature of the enterprise and the difficult mining conditions of the U-G orebody, whether it was mined from the surface or from underground. Table 14 lists the royalty payments.

Depletion deductions can be classified into cost and statutory, or percentage depletion. Cost depletion deductions are considered to be the exploration and acquisition costs required to develop the orebody pro-rated over the life of the mine. Statutory depletion is defined as 15% (for gold) of the gross income from mining or 50% of the pre-tax net income calculated without the depletion allowance, whichever is smaller. Either cost or statutory depletion deductions may be used whichever is greater. In most cases, statutory depletion deductions are much higher than cost depletion deductions (Hoskins, 1977).

The source and type of financing is one of the most critical parameters involved in mine planning. In any mining venture, the initial capital cost is very high, and repayment on the investment requires several years. For this reasons, the cost of money or the

Table 14. Payments paid to the property owners by the mine operators as compensation for mining privileges at various gold prices (1000's dollars)

Average Price of Gold ($/oz)	Annual Payments to Owner (Years)							
	0	1	2	3	4	5	6	Total
450	35	-	8	70	49	85	47	294
550	35	-	55	135	106	149	103	583
600	35	-	79	162	134	182	132	724
625	35	-	91	178	149	198	146	797
650	35	-	103	192	162	214	160	866
750	35	-	150	254	219	279	216	1153
1000	35	-	274	407	363	440	356	1875

discount rate will be higher than the interest rates provided for other types of investment. The discount rate is applicable in the financial analysis of the cash flows and their relationship to the original capital investment.

Three financing techniques are compared and contrasted in the financial analysis of the U-G mining operation. These include low-interest state financing, in-house equity financing and debt-equity financing. Low interest state financing is a new concept in Alaska, born from the State's recent oil bonanza. The purpose of these loans is to stimulate development of stable industries within the State in order to benefit the residents of Alaska. The interest rate charged on these loans is 10%. Equity financing within the operating company would carry a higher interest rate than would state loans. This reflects the opportunity costs of these funds. Historically, this is a more common source of funds, with a company financing new ventures from the cash flow of other projects. The discount rate on this financing technique is assumed to be 14%. Debt-equity financing, or the use of financial leverage, has become very attractive in recent years as a form of capital acquisition. The advantage to this type of arrangement is that interest payments to the debt source can be charged against income for corporate tax purposes as an expense item. This is more attractive because of the tax laws than equity capital dividends paid after taxes (Whitney, 1978).

For the U-G orebody, the discount rate on leveraged financing is assumed to be 18%. This is higher than equity financing for two primary reasons. First, because of the previously discussed tax benefits, the debt market can bear a higher interest rate (Pappas, 1979). Secondly, a mining company is not in the lending business, that is, a mining company maximizes its income primarily from mine revenue, not from investment dividends. Therefore, it will be willing to accept a lower discount rate on in-house fundings in order to continue operations.

Since equity financing requires a lower interest rate than financial leverage, by definition the discounted cash flow (D.C.F.) rate of return on equity capital will be higher than the D.C.F. rate of return on total capital at risk. The D.C.F. rate of return on total capital at risk provides a more meaningful guide to the attractiveness of a property since it reflects the return on funds generated within the marketplace. (Watts, Griffis and McQuat, LTD., 1973.)

Marketing of the final metal product, a very significant parameter in most mining ventures, is not significant with respect to the U-G orebody. Gold, a universally accepted medium of wealth, will be the final product and cash revenues can be accrued simultaneously with the washing, cleaning and refining operation.

Cash Flow Estimation

Over the past decade, gold has reestablished its position as a monetary unit, a standard of real wealth. While its price has been erratic at times, reflecting the general uncertainty of international affairs, it has generally maintained a value reflecting the inflation rate of the major world currencies. It can then be assumed that any cost increases due to inflation can be negated by a corresponding increase in the value of the gold produced. This provides for the use of stable costs and stable product prices over the life of the mine. This washout of inflated costs and escalated incomes will provide for a steady net income without negating inflation expectations in the discount rate (Stermole, 1974).

Cash flows for each year of production in the U-G orebody are calculated at several average price levels for gold. The price levels used are \$450, \$550, \$600, \$625, \$650, \$750 and \$1000 per ounce of gold. While many "experts" maintain that the price of gold will rise well above \$1000, just as many predict prices to fall below \$450. This price range reflects reasonable expectations for the price of gold over the medium term.

Appendix H lists the cash-flow calculations for each year of mining at each gold price. The assumptions used in these calculations follow standard accounting principles. A summary of these cash flows is given on Table 15. It is interesting to note that at \$450/oz gold there is a taxable profit in only the fifth year. At \$1000 an

Table 15. Summary of cash flow estimations for an underground placer mining operation at each year of production (1000's dollars).

Average Price of Gold ($/oz)	Annual Net Cash Flow (Years)				
	2	3	4	5	6
450	100	929	651	1072	625
550	731	1672	1279	1668	1244
600	1021	1825	1556	1970	1506
625	1136	1978	1695	2025	1637
650	1248	2121	1828	2235	1763
750	1709	2592	2339	2654	2247
1000	2740	3705	3381	3721	3159

ounce gold, an average of almost a million and a half dollars is paid annually in income tax. The price of gold plays an extremely important role in the viability of this and any gold venture.

Financial Analysis

The primary aim of any feasibility study is to determine the ability of the project's cash flows to return the initial investment. The principle of the time value of money is critical to this aspect. A dollar today is worth more than a dollar received tomorrow, due to the ability of the dollar received today to be put to use in order to generate additional dollars. A dollar received tomorrow has no use today; hence, it will be worth less than today's dollar.

The time-value of money is reflected by the discount rate, or cost of money. All cash flows expected in future years must be discounted to their present value. By comparing the cost of the venture at its present value to the present value of the cash flows, the net present value of the investment can be readily determined.

Appendix I presents in detail the cash flow of each year and the present value of those cash flows. The ability of the cash flows to pay back the initial investment is determined by the present worth value (P.W.V.). A positive P.W.V. indicates the real gain in dollars at the present time of the investment. Conversely, a negative P.W.V. indicates a real loss involved in the investment. A P.W.V. of exactly zero indicates that the investment has seen no real gain or loss, the investment has paid itself back and no more. This can be considered the breakeven point of the investment.

The P.W.V. is derived at three financing rates; 10%, 14%, and 18% in accordance with the respective financing technique. In addition, the P.W.V. at each interest rate is calculated at a gold price of \$450, \$550, \$600, \$625, \$650, \$750 and \$1000 reflecting the range of possible gold prices per ounce. Table 16 summarizes these data. It is obvious that at any interest rate, a gold price of \$550 an ounce or less renders the U-G placer operation non-viable.

To find the specific breakeven price of gold to return the initial investment, refer to Figure 31, which presents the present worth value summary in graphical format. The values form straight-line relationships in the middle range of gold values. A breakeven point at each interest rate is easily found in this manner. Table 17 presents these breakeven gold prices. At 10% cost of money an average gold price of \$563 per ounce is required. At a 14% cost of money an average gold price of \$592 per ounce is needed. Finally, given an 18% cost of money, a gold price of \$627 per ounce is required to break even.

Range and Limits of Accuracy of the Financial Evaluation

A feasibility study of a mining venture is never more than an estimation of the viability of the project. This is entirely dependent on the cost, production, revenue and financing assumptions.

Table 16. Financial analysis summary - Present worth of the investment (1000's dollars).

Gold Price Per Ounce	Discount Interest Rate		
	0.10	0.14	0.18
450	(2712)	(2858)	(2960)
550	(347)	(776)	(1112)
600	602	59	(374)
625	1048	454	(22)
650	1573	913	379
750	3328	2461	1756
1000	7248	5922	4835

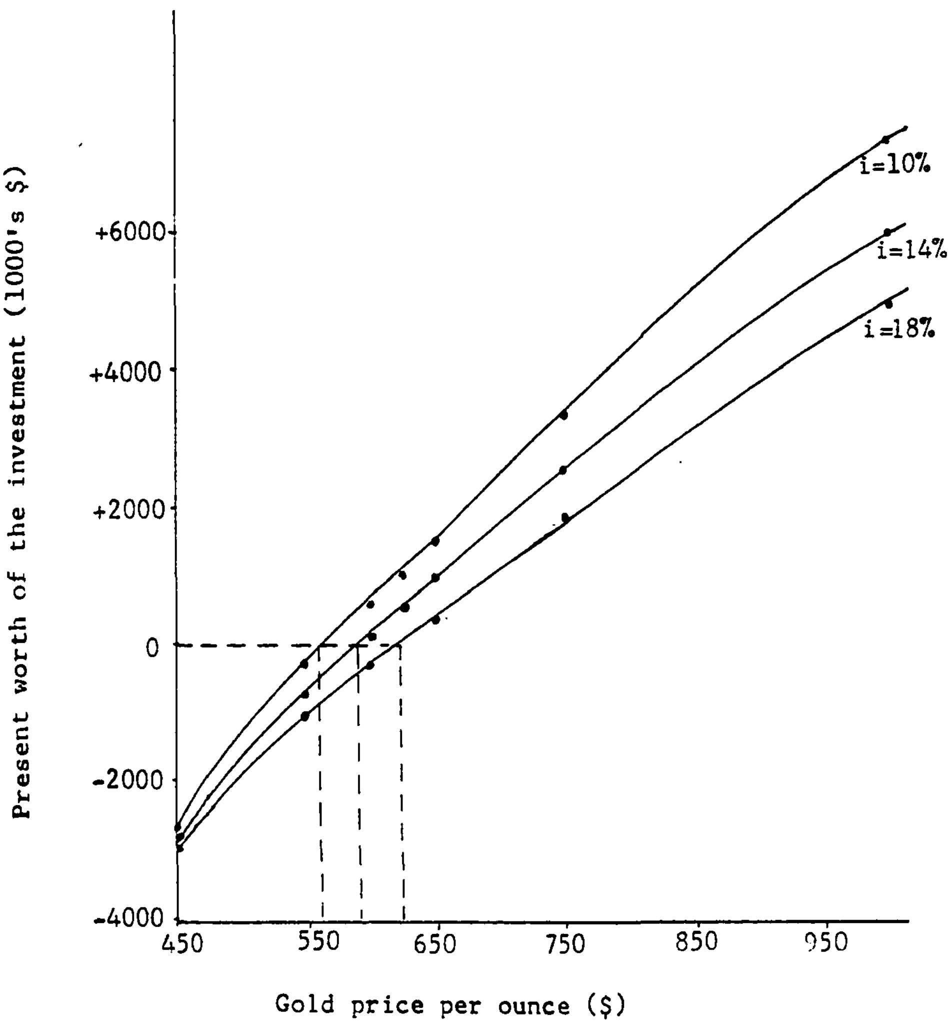


Figure 31. Financial analysis summary - Present worth of the investment vs. the average price of gold at the time of the investment at various discount rates.

Table 17. Break-even gold prices for capital repayment given alternative financing techniques.

Type of Financing	Discount Rate	Break-even Gold Price Per Ounce
State - subsidized Low Interest Mining Loans	10%	$ 563.00
In-House Equity Financing	14%	$ 592.00
Debt/Equity Risk Financing	18%	$ 627.00

The first and primary assumption deals with the orebody itself, the yardage and grade of material to be mined. It is accepted as a truism that the actual parameters of an orebody are never known until it has been mined out. In the case of the U-G orebody, only borehole values are known and a statistically reliable estimate is not possible. If the aim of the valuation is to justify making relatively small expenditures to refine the reserve parameters, optimistic ore values similar to those produced by triangle valuation would be sufficient. If the valuation parameters are to be used to judge the viability of a mining technique, a more conservative view, such as that employed in the computer isopach procedure, would be more appropriate.

The second assumption deals with the performance of the operation. This encompasses two items, production and recovery. The mine equipment employed in the operation must be capable of performing at the rate of output assumed in the feasibility study. Study of the cycle times and proper matching of the equipment is necessary to accurately make the production assumption. These cycle times must include normal hourly downtime in addition to unexpected maintenance downtimes. The maintaining of an inventory of spare equipment will greatly facilitate meeting of production guidelines. Recovery is more difficult to adequately assess. This will affect mining of the U-G orebody in two ways. The first involves the pillar loss factor. Pillars may or may not have to be used, as previously mentioned. In the case they are needed, spotty, low-value ground within the main gravel section can be selectively chosen as pillar sites. This is due to the easily testable nature of the placer gravels. Gravel can be brought to the surface and panned, thereby aiding in the spot checks of the gold values.

The final recovery factor in the performance is the efficiency factor of the sluicing or washing system. For ores requiring complex mill treatments, this can be a problem. Much of the placer drill evaluation used rocker boxes and pans to recover gold in the drill holes. These approximate the recovery efficiency of the washing plants, thus resolving any efficiency problems. As a matter of fact, actual recoveries are higher than estimated recoveries, in relative values ranging from 3% to 10%, to as high as 60% and 100% (Ross, 1979). Fo the U-G orebody, a washing system can be employed to conservatively recover 100% of the estimated gold content.

A third major assumption area deals with the assumed capital and operating costs. For the most part, these costs can be reliably determined with price quotes and project estimates by equipment manufacturers, contractors and specialized operating cost guide-books. Expected over-runs from these estimates, such as winter conditions and freight can be conservatively estimated and added to the costs. For unexpected cost overruns, such as strikes, accidents, or acts of God, a contingency allowance should be provided. A 15% contingency allowance on all capital equipment and development has been added to the U-G initial costs.

Inflation is an unknown factor that is totally unpredictable over the life of the mine. There are several ways of dealing with this factor, none of which are particularly reliable. In a gold property, the most appropriate manner in which to treat inflation is to assume that the price of gold, the ultimate form of money, will rise with respect to a rise in general price levels. This concept of gold's "real value" is accepted world wide (Mining Journal, December 1979).

Lastly, the assumptions made with regard to price and revenue estimation play a key role in determining the feasibility of a project. Several average prices of gold are presented in the financial summary and cash flows. This price of gold is taken as the mid-range price, averaging the short term volatile fluctuation caused by world events. Long-range changes in the price of gold have been discussed and are assumed to reflect and equate to a general rise in prices. This is not to say that short-term fluctuations have no effect on the viability of the operation. On the contrary, a sophisticated sytem of holding gold in inventory and selling during high-price periods will greatly enhance the economics of the project. Economic viability must be shown at a conservative product price however, for a reliable feasibility decision.

ECONOMIC VIABILITY OF THE PROJECT

In every feasibility study, the goal is to determine if the venture shows at least the lowest level of profitability at conservative production, cost and price parameters. In addition to this, all factors which may increase a project's viability must be considered and summarized. If the feasibility study reflects the worst case or conservative assumptions, considerations must be given at the start on factors which may be improved during the course of the operation.

There are dozens of ways in which any project may be improved. In summary, some of the ways in which an underground mining operation on the U-G orebody can be made more attractive include the following:

1. Improved mining methods may be developed as a result of testing and experience, especially since this is a new technique. Possible improvements range from modifications to the existing drill-blast-muck cycle to the implementation of new, exotic techniques such a continuous mining, localized thawing, etc.
2. The production schedule assumes a 6 day work week and a 6 month mining season. Experience may find that a longer work week and work season are economically attractive. By repaying the initial investment quicker, the viability of the project is greatly enhanced. This is dependent on diminishing marginal returns and the lease/

leasor relationship (Anders, 1980).

3. Some of the gold produced can be held and released during gold price peaks to increase revenues. This is similar to the strategy used by South Africa and the Soviet Union. (Mining Journal, October, 1980.)

4. Washing efficiency of modern sluice plants has increased over the years. If the mine recovery system is more efficient than the drilling recovery system, the gravels may produce more gold than anticipated.

5. The U-G orebody is but one tabular paystreak of many within Livengood Creek placer deposit. It is quite conceivable that an overall mining plan of several orebodies can be incorporated together, either simultaneously or in a stepwise fashion. The economics of scale and the lengthened use of existing equipment would favorably affect the development.

6. No salvage value of the mine plant is assumed. In reality, there might be a salvage value. A salvage value at year 6 of $700,000 for the entire plant for instance, would result in a present value of $319,200, assuming a 14% discount rate. This would be credited directly to the NPV and greatly enhance the project's viability.

7. The present improvements on the Livengood property are not considered. If they are incorporated into the analysis, a capital savings of up to $430,000 in support costs can be credited directly to the NPV.

These factors are all important and useful in making the final feasibility decision. At present, a price of gold of $600 per ounce can be considered stable, and a minimum base price of $450 per ounce can be thought of as reasonable. An upper limit in the short term cycles can only be speculated on, but the "crisis demand" price of $850 per ounce has already been reached. (Mining Journal, June 1980.)

Given a discount rate of 14% and an average gold price of $600 per ounce, an underground mining operation in the U-G orebody exhibits an extremely low level of profitability. The present value of the investment at these assumptions is only $59,000. Since all effort has been made to list the costs and revenues conservatively and by accounting for the above mentioned factors which would favorably influence feasibility, this project can be considered a viable investment. If the feasibility study of this or any project maintains a positive present value in a conservative analysis, the project can be considered a sound one.

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APPENDICES

Appendix A. Block valuation calculations

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. of Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
29/A	20		0	21	1.98	-	2100	4158	
	21	100	0	17	.46	-	2550	1173	
	21.5	50	0	18	.18	-	1800	324	
	22	50	0	12	1.39	-	1800	2502	
	23	100	0	10	1.11	-	1500	1665	
	23½	50	0	21	2.45	-	2100	5145	
	24	50	0	10	4.31	-	1500	6465	
	25	100	0	11	4.50	-	1650	7425	
	25A	50	0	17	1.08	-	1700	1836	
	26	50	0	20	5.81	-	3000	17430	
	27	100	0	16	0.26	-	2400	624	
	27A	50	0	16	0.83	-	1600	1328	
	28	50	44	22	0.27	6600	3300	891	
	29	100	43	16	0.52	8600	3200	1664	
	30	100	46	18	0.00	9200	3600	-	
	31	100	38	10	0.06	11400	3000	180	
	33	200	40	10	0.09	12000	3000	270	
	34	100	44	11	1.10	8800	2200	2420	
	35	100	0	14	0.64	-	2100	1344	
	35A	50	0	7	0.68	-	700	476	
	36	50	5	7	0.60	250	350	210	
						56,850	87,150	57,530	480
						28,425	43,575	28,765	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
28/A	36	100	32	65	1.05	3200	6500	6825	
	35	100	54	56	0	10800	11200	-	
	34	100	4	17	0.85	800	3400	2890	
	33	100	18	8	0.88	3600	1600	1408	
	32	100	2	28	1.36	400	5600	7616	
	31	100	17	21	0.38	3400	4200	1596	
	30	100	13	30	0.16	2600	6000	960	
	29	100	0	29	0.55	-	5800	3190	
	28	100	0	26	0.35	-	5200	1820	
	27	100	9	17	0.29	1800	3400	986	
	26	100	0	26	0.43	-	5200	2236	
	25	100	14	16	1.02	2800	3200	3264	
	24	100	15	17	0.42	2250	2550	1071	
	23½	50	14	12	2.42	1400	1220	2904	
	23	50	12	12	0.14	1200	1200	168	
	22½	50	11	5	2.12	1100	500	1024	
	22	50	16	8	0.13	1600	800	104	
	21½	50	20	5	0.08	2000	500	40	
	21	50	0	14	0.12	-	1400	168	
	20½	50	0	11	0.77	-	1100	847	
	20	50	0	25	0.07	-	2500	175	
						38,950	73,050	39,292	480
						19,475	36,525	19,646	

Line-Back	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. of Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
29/B	20-36	See Exhibit A-2				56850	87150	57530	
	36		5	7	.68	500	700	476	
	37	100	5	12	.60	750	1800	1080	
	37A	50	0	21	.49	-	2100	1029	
	38	50	0	9	.59	-	1450	855	
	39	100	4	6	1.27	600	900	1143	
	39A	50	6	14	0.38	600	1400	532	
	40	50	10	8	5.65	1500	1200	6780	
	41	100	40	0	0.00	4000	-	-	
						64,800	96,700	69,425	490'
						32,400	48,350	34,712	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. of Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
30/B	26		34	14	.17	3400	1400	238	
	27	100	32	18	.33	6400	3600	1200	
	28	100	39	17	.22	7800	3400	748	
	29	100	49	15	.09	9800	3000	270	
	30	100	50	17	-	10000	3400	-	
	31	100	51	14	.16	10200	2800	448	
	32	100	56	18	.07	11200	3600	252	
	33	100	57	19	.13	17100	5700	741	
	35	200	34	23	.26	10200	6900	1794	
	36	100	35	15	1.55	7000	3000	4650	
	37	100	40	25	.84	8000	5000	4200	
	38	100	32	36	.67	6400	7200	4824	
	39	100	17	29	.50	3400	5800	2900	
	40	100	11	29	.11	2200	5800	639	
	41	100	8	35	.16	800	7000	1120	
	42	100	55	25	.07	5500	2500	175	
						119,400	75,100	24,198	490'
						59,700	37,550	12,099	
30/C	26-42					119400	75100	24198	
	42		55	25	.07	5500	2500	175	
	43	100	53	36	0.29	10600	7200	2088	
	44	100	58	25	-	5800	2500	-	470'
						141,300	87,300	26,461	
						70,650	43,650	13,230	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. of Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing VAL/C.Y.	Block Spacing
31/D	29		27	6	0	2700	600	0	
	30	100	71	6	0	14200	1200	0	
	31	100	66	13	0.47	13200	2600	1222	
	32	100	69	19	0.61	13800	3800	2318	
	33	100	74	26	0.31	14800	5200	1612	
	34	100	78	29	0.62	15600	5800	3596	
	35	100	83	29	1.97	16600	5800	11426	
	36	100	81	33	1.18	16200	6600	7788	
	37	100	87	32	1.09	17400	6400	6976	
	38	100	92	28	0.30	18400	5600	1680	
	39	100	93	28	0.20	18600	5600	1120	
	40	100	99	18	0.40	19800	3600	1440	
	41	100	98	26	0.04	19600	5200	208	
	42	100	109	7	0.31	21800	700	217	
						222,700	58,700	39,603	470'
						111,350	29,350	19,802	
31/C	29-42					222700	58700	39603	470
	29		27	6	0	2700	600	-	
	28	100	39	9	0.49	7800	1800	882	
	27	100	40	8	0.10	8000	1600	160	
	26	100	40	9	0.15	8000	1800	270	
	25	100	48	9	0.36	9800	1800	648	
	24	100	44	16	0.35	8800	3200	1120	
	23	100	48	16	1.49	4800	1600	2384	
						272,600	71,100	45,067	
						136,300	35,550	22,533	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
31/E	29-23					49900	12400	5464	
						24950	6200	2732	1420
32/D	30		60	8	.1	6000	800	80	
	31	100	54	8	.09	10800	1600	144	
	32	100	52	9	.29	10400	1800	522	
	33	100	41	9	1.12	6150	1350	1512	
	33A	50	56	11	.19	5600	1100	209	
	34	50	56	12	.35	8400	1800	630	
	35	100	63	15	.24	9450	2250	540	
	35A	50	68	14	.85	6800	1400	1190	
	36	50	75	14	.68	11250	2100	1260	
	37	100	72	12	.80	10800	1800	1440	
	37A	50	74	11	2.68	7400	1100	2948	
	38	50	74	14	.33	11100	2100	700	
	39	100	77	20	.21	11500	3000	700	
	39A	50	86	21	6.35	8600	2100	13335	
	40	50	86	14	0.18	12900	2100	378	
	41	100	86	41	6.44	12900	6150	39606	
	41A	50	70	18	0.90	7000	1800	1620	
	42	50	60	26	0.04	9000	3900	156	
	43	100	82	0	0.00	8200	0	0	470
						174,250	38,250	66,970	
						87,125	19,125	33,485	
32/F	30-43					174250	38250	66970	
						87125	19125	33485	460

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
33/F	30		41	15	.07	4100	1500	105	
	31	100	50	6	.22	10000	1200	264	
	32	100	51	7	0	10200	1400	0	
	33	100	62	11	.16	12400	2200	352	
	34	100	72	13	.17	14400	2600	442	
	35	100	67	18	1.36	13400	3600	4896	
	36	100	67	13	3.50	13400	2600	9100	
	37	100	82	21	1.21	16400	4200	5082	
	38	100	82	20	1.33	16400	4000	5320	
	39	100	90	31	1.17	13500	6200	7254	
	39A	50	80	52	1.19	8000	7800	9282	
	40	50	85	33	9.80	8500	3300	32340	
	40A	50	85	29	3.39	8500	2900	9831	
	41	50	85	22	1.96	12750	3300	6468	
	42	100	78	22	0.12	7800	2200	264	460
						169,750	49,000	91,000	
						84,875	24,500	45,500	
33/G	30-42					169,750	49,000	91,000	480
						84,875	24,500	45,500	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
34/G	29		42	9	.15	4200	900	135	
	30	100	37	0	.00	11100	0	0	
	32	200	65	10	.53	19500	3000	1590	
	33	100	73	13	.35	14600	2600	910	
	34	100	78	11	1.69	7800	2200	3718	
	35	100	78	13	1.31	7800	2600	3406	
	36	100	80	13	1.25	8000	2600	3250	
	37	100	78	13	1.67	11700	1950	3256	
	37A	50	83	10	3.51	8300	1000	3510	
	38	50	89	31	6.97	8900	3100	21607	
	38A	50	90	21	0.35	9000	2100	735	
	39	50	96	18	0.55	14400	2700	1485	
	40	100	102	21	0.26	20400	4200	1092	
	41	100	71	18	0.35	14200	3600	1260	
	42	100	69	0	0.00	6900	0	0	480'
						166,800	32,550	45,954	
						83,400	16,275	22,977	
34/H	29-42					83,400	16,275	22,977	780'
34/E	22		41	31	0.13	4100	3100	403	
	23	100	48	30	0.12	9600	6000	720	
	24	100	64	17	0.18	19200	5100	918	
	26	200	75	12	0.16	22500	3600	576	
	27	100	64	11	0.02	12800	2200	44	
	28	100	53	12	1.10	10600	2400	2640	
	29	100	42	9	0.15	4200	900	135	1420'
						83,000	23,300	5,436	
						41,500	11,650	2,718	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
34/I	22-29					41,500	11,650	2,718	1820'

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
36/H	28		21	12	.12	2100	1200	144	
	29	100	45	16	1.57	6700	2400	3768	
	29A	50	45	21	.70	4500	2100	1470	
	30	50	54	10	1.19	8200	1500	1785	
	31	100	54	14	.38	8200	2100	798	
	31A	50	52	19	.75	5200	1900	1425	
	32	50	64	10	.19	9600	1500	285	
	33	100	64	8	1.55	9600	1200	1860	
	33A	50	70	14	1.56	7000	1400	2184	
	34	50	70	8	1.10	9100	1040	1144	
	35	80	77	10	.43	12320	1600	688	
	35A	80	90	8	.71	11700	1040	738	
	36	50	92	7	.08	13800	1050	84	
	37	100	91	13	2.34	13650	1950	4563	
	37A	50	94	13	2.81	9400	1300	3653	
	38	50	98	10	.69	14700	1500	1035	
	39	100	92	20	1.50	13800	3000	4500	
	39A	50	82	24	1.63	8200	2400	3912	
	40	50	86	9	1.76	12900	1350	2376	
	41	100	84	7	.67	8400	700	469	780
						189,000	32,250	36,881	
						94,500	16,125	18,440	
36/K	28-41					94,500	16,125	18,440	730

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
36/J	13		12	14	0.90	1200	1400	1260	
	14	100	9	12	.93	1800	2400	2232	
	15	100	7	12	.36	1400	2400	864	
	16	100	7	11	.02	1400	2200	44	
	17	100	9	10	.28	1800	2000	560	
	18	100	13	13	.10	1300	1300	130	1100'
						8,900	11,700	5,090	
						4,450	5,850	2,545	
38/L	39		98	8	1.23	11760	960	1180	
	40	120	83	6	.17	18260	1320	224	
	41	100	86	32	.45	17200	6400	2880	970'
	42	100	15	112	0	1500	11200	0	
						48,270	19,880	4,284	
						24,360	9,940	2,142	
38/M	25		8	13	.07	1600	2600	182	
	27	200	30	18	.11	12000	7200	792	
	29	200	37	13	.19	14800	5200	988	
	31	200	32	12	.42	9600	3600	1512	
	32	100	33	12	.19	6600	2400	456	
	33	100	22	0	.00	4400	0	0	
	34	100	64	16	.40	12800	3200	1280	
	35	100	74	21	.45	14800	4200	1890	
	36	100	88	16	1.51	17600	3200	4832	
	37	100	108	6	.52	21600	1200	624	
	38	100	86	19	0	17200	3800	0	
	39	100	98	8	1.23	9800	800	984	480
						142,800	37,400	13,540	
						71,400	18,700	6,770	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
38/K	39-42					24360	9940	2142	
	25-39					71400	18700	6770	730'
						95,760	28,640	8,912	
38/O	23		1	22	.06	200	4400	264	
	25	200	8	13	.07	1600	2600	182	
						1,800	7,000	446	990'
						900	3,500	223	
38/J	12		4	18	.63	400	1800	1134	
	14	100	7	7	.25	1400	1400	350	
	15	100	2	15	.02	600	4500	90	
	17	200	10	9	.20	3000	2700	540	
	18	100	7	10	.56	1400	2000	1120	
	19	100	10	10	.14	1000	1000	140	1100
						7,800	13,400	3,374	
						3,900	6,700	1,687	
38/P	13-19					3,900	6,700	1,687	780
38/I	23-25					1800	7000	446	
	19		10	10	.14	2000	2000	280	
	21	200	7	11	.12	2800	4400	528	
	23	200	1	22	.06	200	4400	264	
						6,800	17,800	1,518	
						3,400	8,900	759	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
39/M	25		48	12	.29	4800	1200	348	
	26	100	46	14	.27	13800	4200	1134	
	28	200	24	4	0	9600	1600	0	
	30	200	20	0	0	6000	0	0	
	31	100	18	8	0	3600	1600	0	
	32	100	40	17	.13	8000	3400	442	
	33	100	46	10	.73	9200	2000	1460	
	34	100	50	8	.41	10000	1600	656	
	35	100	48	6	.27	9600	1200	324	
	36	100	84	12	.69	16800	2400	1656	
	37	100	86	10	.93	17200	2000	1860	
	38	100	106	10	1.72	10600	1000	1720	480
						119,200	22,200	9,600	
						59,600	11,100	4,800	
39/N	25-38					59,600	11,100	4,800	500
40/O	23		10	16	.12	1000	1600	192	
	24	100	24	9	.58	4800	1800	1,044	
	25	100	30	9	1.38	3000	900	4,140	
						8,800	4,300	5,376	
						4,400	2,150	2,688	
40/P	15		5	7	.46	150	210	96	
	16	30	2	13	.19	120	780	148	780
	17	30	2	11	.16	60	330	52	
						330	1,320	296	
						165	660	148	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
40/L	38		85	10	5.17	8500	1000	5170	
	39	100	70	37	0.06	14000	7400	444	
	40	100	75	6	0.41	7500	600	246	970
						30,000	9,000	5,860	
						15,000	4,500	2,930	
40/N	25		30	9	1.38	3000	900	1242	
	26	100	30	15	.13	6000	3000	390	
	27	100	20	10	.68	4000	2000	1360	
	28	100	25	16	.48	5000	3200	1536	
	29	100	33	10	.41	6600	2000	820	
	30	100	43	7	1.65	8600	1400	2310	
	31	100	49	7	.87	9800	1400	1218	
	32	100	48	11	.06	9600	2200	132	
	33	100	56	12	.40	11200	2400	960	
	34	100	56	7	2.67	11200	1400	3738	
	35	100	32	10	.19	6400	2000	380	
	36	100	47	7	4.05	9400	1400	5670	
	37	100	58	11	0	11600	2200	0	
	38	100	85	10	5.17	8500	1000	5170	500
						110,900	26,500	24,926	
						55,450	13,250	12,463	
40/Q	25-38					15000	4500	2930	
	38-40					55450	13250	12463	1000
						70,450	17,750	15,393	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
40/R	15-17					165	660	148	650
41/R	14		8	10	1.1	400	500	550	
	14A	50	1	17	5.35	100	1700	9095	
	15	50	2	12	.20	200	1200	240	
	15A	50	0	12	.71	0	1200	852	
	16	50	0	10	.34	0	1000	340	
	16A	50	1	12	.37	50	600	222	650
						750	6,200	11,299	
						375	3,100	5,650	
41/S	14-16A					375	3,100	5,650	570
42/S	14		11	15	.87	1100	1500	1305	
	15	100	0	20	.01	0	4000	40	
	16	100	6	9	1.61	1200	1800	2898	
	17	100	11	11	0.01	2200	2200	22	
	18	100	10	10	0.09	1000	1000	90	570
						5,500	10,500	4,355	
						2,750	5,250	2,177	
42/W						2,750	5,250	2,177	620

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	
42/T	28		40	15	.48	4000	1500	720	
	29	100	36	15	.38	7200	3000	1140	
	30	100	30	21	.94	6000	4200	3948	
	31	100	35	21	.14	7000	4200	588	
	32	100	25	29	.13	5000	5800	754	
	33	100	20	25	.01	4000	5000	50	
	34	100	23	26	1.16	4600	5200	6032	
	35	100	17	27	1.46	3400	5400	7884	
	36	100	35	12	1.27	7000	2400	3048	
	37	100	36	7	.27	7200	1400	378	
	38	100	41	3	.10	8200	600	60	
	39	100	40	8	2.18	8000	1600	3488	
	40	100	35	15	.32	3500	3000	960	500
						75,100	43,300	29,050	
						37,550	21,650	14,525	
42/V	26		43	12	.05	4300	1200	60	
	27	100	52	9	.46	10400	1800	828	
	28	100	40	15	.48	4000	1500	720	1000
						18,700	4,500	1,608	
						9,350	2,250	804	
42/Q	26-40					9350	2250	804	
						37550	21650	14525	1000
						46,900	23,900	15,329	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
43/T	28		48	6	.08	4800	600	48	
	29	100	52	8	.52	10400	1600	832	
	30	100	68	8	1.89	13600	1600	3024	
	31	100	77	8	.06	15400	1600	96	
	32	100	62	28	.18	12400	5600	1008	
	33	100	60	28	.64	12000	5600	3584	
	34	100	50	44	2.43	10000	8800	21384	
	35	100	50	8	2.46	10000	1600	3936	
	36	100	21	39	.04	4200	7800	312	
	37	100	28	45	.44	5600	9000	3960	
	38	100	42	46	.49	8400	9200	4508	
	39	100	64	8	.64	6400	800	512	500
						113,200	53,800	43,204	
						56,600	26,900	21,602	
43/U	28-39					56,600	26,900	21,602	510
43/W	16		6	14	.26	300	700	182	
	16A	50	7	16	.10	1050	2400	240	
	17	100	11	9	.51	1100	900	459	600
						2,450	4,000	881	
						1,225	2,000	440	
43/X						1,225	2,000	440	900

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
44/U	28		68	7	.04	5440	560	22.4	
	29	80	64	9	.18	10240	1440	259.2	
	30	80	64	8	.34	10240	1440	489.6	
	31	80	63	11	1.05	11340	1980	2079	
	32	100	62	9	.28	12400	1800	504	
	33	100	60	18	.61	12000	3600	2196	
	34	100	57	28	.06	11400	5600	336	
	35	100	62	35	.38	12400	7000	2660	
	36	100	69	32	.13	15180	7040	915.2	
	37	120	65	34	.03	14300	7480	224.4	
	38	100	56	28	.23	11200	5600	1288	
	39	100	60	54	.36	12000	10800	3888	
	40	100	40	49	1.32	8000	9800	12936	
	41	100	45	50	0.03	4500	10000	300	510
						150,640	74,140	28,097	
						75,320	37,070	14,048	
44/V	28		68	7	.04	10880	1120	44.8	
	26	160	54	7	.08	8640	1120	89.6	1000
						19,520	2,240	134.4	
						9,760	1,120	67.2	
44/Y	28-26					9760	1120	67.2	
	28-41					75320	37070	14048	1060
						85,080	38,190	14,115	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y.	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VA./C.Y.	Block Spacing
45/X	15½		10	14	1.31	500	700	910	
	16	50	9	13	.24	900	1300	312	
	16½	50	15	8	.23	1500	800	184	
	17	50	13	11	.14	1300	1100	154	
	17½	50	15	10	.39	1500	1000	390	
	18	50	18	8	.06	1800	800	54	
	18½	50	22	8	.03	1100	400	12	900
						8,600	6,100	2,016	
						4,300	3,050	1,008	
45/Z	15½-18½					8600	6100	2016	
	18½		22	8	.03	1100	400	12	
	19	50	19	14	.24	1900	1400	336	
	19½	50	26	10	0	2600	1000	0	
	20	50	31	5	.31	3100	500	155	
	20½	50	29	4	.42	2900	400	128	
	21¼	50	32	4	.20	3200	400	80	
	21¼	50	25	6	.25	2500	600	150	
	22¼	50	9	25	.18	450	1250	225	460
						273.50	12,050	3,102	
						136.75	6,025	1,551	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
46/X	30		56	11	.82	5600	1100	902	
	31	100	61	10	.84	12200	2000	1680	
	32	100	68	12	11.33	13600	2400	27192	
	33	100	73	9	0.42	14600	1800	756	
	34	100	78	6	1.40	15600	1200	1680	
	35	100	77	8	1.29	15400	1600	2064	
	36	100	84	5	0.65	16800	1000	650	
	37	100	83	9	0.12	16600	1800	216	
	38	100	80	15	0.04	16000	3000	120	
	39	100	84	11	2.52	16800	2200	5544	
	40	100	100	6	4.91	10000	1200	5892	460
						153,200	19,300	46,696	
						76,600	9,650	23,248	
46/Y	30-40					153200	19300	46696	
	25		53	6	1.54	5300	600	924	
	26	100	59	7	.79	11800	1400	1106	
	27	100	56	14	.14	11200	2800	392	
	28	100	53	3	.46	10600	600	276	
	29	100	54	12	1.86	10800	2400	4464	
	30	100	56	11	.82	5600	2200	1804	1060
						208,500	29,300	55,662	
						104,250	14,650	27,831	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
46/Ō	25-30					55300	10000	8966	
	25		53	6	1.54	5300	600	924	
	24	100	47	12	.50	9400	2400	1200	
	23	100	40	14	.74	8000	2800	2072	
	22	100	28	12	.13	5600	2400	312	
	21	100	26	8	1.00	5200	800	800	1000
						88,800	24,400	14,274	
						44,400	12,200	7,137	
46/Z	14		14	8	1.55	1400	800	1240	
	15	100	9	8	.89	1800	1600	1424	
	16	100	13	15	.11	3900	4500	495	
	18	200	21	17	.26	8400	6800	1768	
	20	200	20	6	.27	6000	1800	486	
	21	100	26	8	1.00	5200	1600	1600	
	22	100	28	12	.13	5600	2400	312	
	23	100	40	14	.74	4000	1400	1036	460
						36,300	20,900	8,361	
						18,150	10,450	4,180	
46/&	12		10	12	.23	1000	1200	276	
	13	100	7	18	1.58	1400	3600	5688	
	14	100	14	8	1.55	1400	800	1240	
	14-21					24100	16300	6213	600
						27,900	21,900	13,417	
						13,950	10,950	6,709	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
47/2	29		26	10	.05	2600	1000	50	
	30	100	40	14	.06	8000	2800	168	
	31	100	49	13	.50	9800	2600	1300	
	32	100	55	12	.85	11000	2400	2040	
	33	100	60	12	.04	12000	2400	96	
	34	100	71	0	0	14200	0	0	
	35	100	72	9	.06	14400	1800	108	
	36	100	76	12	2.10	15200	2400	5040	
	37	100	81	9	.15	8100	900	135	460
						95,300	16,300	8,937	
						47,650	8,150	4,469	
47/B	29-37					47,650	8,150	4,469	500

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	
47/&	11½		12	9	.15	600	450	675	
	12	50	15	6	0	1500	600	0	
	12½	50	9	13	.38	900	1300	494	
	13	50	12	10	.64	1200	1000	640	
	13½	50	13	12	.08	1300	1200	96	
	14	50	14	10	.72	1400	1000	720	
	14½	50	13	12	.23	1300	1200	276	
	15	50	16	12	.71	2400	1800	1278	
	16½	100	9	15	.22	1800	3000	660	
	17	100	24	8	.10	3600	1200	120	
	17½	50	22	10	.70	2200	1000	700	
	18	50	23	9	.15	2300	900	130	
	18½	50	19	7	.50	1900	700	350	
	19	50	21	4	.92	2100	400	368	
	19½	50	24	7	.08	2400	700	56	
	20	50	23	4	.44	1150	200	88	600
						28,050	16,650	6,656	
						14,025	8,325	3,328	
47/II						14,025	8,325	3,328	360

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
48/B	30		30	16	.02	3000	1600	36	
	31	100	43	7	.12	8600	1400	168	
	32	100	40	10	.41	8000	2000	820	
	33	100	45	16	.20	9000	3200	640	
	34	100	54	14	.39	10800	2800	1092	
	35	100	55	9	.09	11000	1800	162	
	36	100	68	8	.10	13600	1600	160	
	37	100	78	9	1.32	15600	1800	2376	
	38	100	82	10	1.61	16400	2000	3220	
	39	100	92	17	.13	18400	3400	442	
	40	100	101	22	.15	10100	4400	660	500
						124,500	26,000	9,776	
						62,250	13,000	4,888	
48/$\bar{O}$	19½		25	8	.52	2500	800	416	
	21	100	26	8	.07	7800	2400	168	
	23	200	27	21	.12	10800	8400	1008	
	25	200	38	8	.06	15200	3200	192	
	27	200	4	10	.18	1200	3000	540	
	28	100	36	20	.03	7200	4000	120	
	29	100	30	10	.11	6000	2000	220	
	30	100	30	16	.02	3000	1600	32	1000
						53,700	25,400	2,696	
						26,850	12,700	1,348	

Line-Block	Hole	Spacing	Depth of Muck	Depth of Gravel	VAL/C.Y. Gravel	Muck x Spacing	Gravel x Spacing	Gravel x Spacing x VAL/C.Y.	Block Spacing
48/II	11		13	8	.78	650	400	312	
	11½	50	17	5	.57	1700	500	285	
	12	50	12	14	.77	1200	1400	1078	
	12½	50	11	14	.52	1100	1400	728	
	13	50	14	12	.54	1400	1200	648	
	13½	50	15	12	.56	1500	1200	672	
	14	50	19	7	1.03	1900	700	721	
	14½	50	15	13	.83	1500	1300	1079	
	15	50	21	7	.58	2100	700	406	
	15½	50	25	5	2.05	2500	500	1025	
	16¼	50	4	8	8.72	400	800	6976	
	17	50	17	5	.27	1700	500	135	
	17¼	50	27	6	1.74	2700	600	1044	
	18½	50	25	4	7.36	2500	400	2944	
	19	50	24	8	1.71	2400	800	1368	
	19½	50	25	8	.52	1250	400	208	
						37,750	12,800	19,629	
						18,875	6,400	9,814	

Appendix B. Block valuation summary calculations

Block	Line	Muck Weight	Gravel Weight	Gold Value Weight	Block Spacing
A	28	19475	36525	19646	
	29	28425	43575	28765	
		47900	80100	48411	480
B	29	32400	48350	34712	
	30	59700	37550	12099	
		92100	85900	46811	490
C	30	70650	43650	13230	
	31	136300	35550	22533	
		206950	79200	35763	470
D	31	111350	29350	19802	
	32	87125	19125	33485	
		198475	48475	53287	470
E	31	24950	6200	2732	
	34	41500	11650	2718	
		66450	17850	5450	1420
F	32	87125	19125	33485	
	33	84875	24500	45500	
		172000	43625	78985	460
G	33	84875	24500	45500	
	34	83400	16275	22977	
		168275	40775	68477	480

Total Muck (C.Y.)	Total Gravel (C.Y.)	Total Oz. Gold	Oz./C.Y. Average
3,973,925	712,000	12,295	.0171
835,722	779,462	12,136	.0156
1,801,231	689,333	8,893	.0129
1,727,467	421,912	13,251	.0314
1,747,388	469,388	4,094	.0087
1,465,185	371,620	19,224	.0517
1,495,777	382,444	17,391	.0480

Block	Line	Muck Weight	Gravel Weight	Gold Value Weight	Block Spacing	Total Muck (C.Y.)	Total Gravel (C.Y.)	Total Oz. Gold	Oz./C.Y. Average
H	34	83400	16275	22977					
	36	94500	16125	18440					
		177900	32400	41417	780	2,569,666	468,000	17093	.0365
I	34	41500	11650	2718					
	38	3400	8900	759					
		44900	20550	3477	1820	1,513,296	692,611	3348	.0048
J	36	4450	5850	2545					
	38	3900	6700	1687					
		8350	12550	4234	1100	170,092	255,648	2464	.0096
K	36	94500	16125	18440					
		95760	28640	8912					
		190260	44765	27352	730	2,572,033	605,156	10564	.0175
L	38	24360	9940	2142					
	40	15000	4500	2930					
		39360	14440	5072	970	707,022	259,385	2603	.0100
M	38	71400	18700	6770					
		59600	11100	4800					
		131000	29800	11570	480	1,164,444	264,888	2938	.0111
N	39	59600	111000	4800					
		55450	13250	12463					
		115050	24350	17263	500	115,550	225,462	4567	.0203
O	38	900	3500	223					
	40	4400	2150	2688					
		5300	5650	2911	990	97,166	52,314	1524	.0291

Block	Line	Muck Weight	Gravel Weight	Gold Value Weight	Block Spacing
P	38	3900	6700	1687	
	40	165	660	148	
		4065	7360	1835	780
Q	40	70450	17750	15393	
	42	46900	23900	15329	
		117350	41650	30722	1000
R	40	165	660	148	
	41	375	3100	5650	
		540	3760	5798	650
S	41	375	3100	5650	
	42	2750	5250	2177	
		3125	8350	7827	570
T	42	37550	21650	14525	
	43	56600	26900	21602	
		94150	48550	36127	500
U	43	56600	26900	21602	
	44	75320	37070	14048	
		131920	63970	35650	510
V	42	9350	2250	804	
	44	9760	1120	67	
		19110	3370	871	1000
W	42	2750	5250	2177	
	43	1225	2000	440	
		3975	7250	2577	620

Total Muck (C.Y.)	Total Gravel (C.Y.)	Total Oz. Gold	Oz./C.Y. Average
58,716	106,311	757	.0071
2,173,148	771,296	16255	.0211
6,500	45,259	1994	.044
32,986	88,138	2360	.0268
871,759	449,537	9557	.0213
1,245,911	604,161	9620	.0159
353,888	62,407	461	.0074
45,639	83,240	845	.0102

Block	Line	Muck Weight	Gravel Weight	Gold Value Weight	Block Spacing
X	43	1225	2000	440	
	45	4300	3050	1008	
		5525	5050	1448	900
Y	44	85080	38190	14115	
	46	104250	14650	27831	
		189330	52740	41946	1060
Z	45	13675	6025	1551	
	46	18150	10450	4180	
		31825	16475	5731	460
Ƶ	46	76600	9650	23348	
	47	47650	8150	4469	
		124250	17800	27817	460
$\bar{P}$	47	47650	8150	4469	
	48	62250	13000	4888	
		109900	21150	9357	500
$\bar{O}$	46	44400	12200	7137	
	48	26850	12700	1348	
		71250	24900	8485	1000
&	47	14025	8325	3328	
	46	13950	10950	6709	
		27975	19275	10037	600
TT	47	14025	8325	3328	
	48	18875	6400	9814	
		32900	14725	13142	360

Total Muck (C.Y.)	Total Gravel (C.Y.)	Total Oz. Gold	Oz./C.Y. Average
92,083	84,167	690	.0082
3,716,477	1,035,266	23525	.0227
271,101	140,342	1395	.0099
1,058,425	151,629	6770	.0447
1,017,592	195,833	2475	.0126
1,319,444	461,111	4489	.0097
310,833	214,166	3186	.0149
219,333	98,166	2503	.0255

Double-End Evaluation

Total For All Blocks

Volume of Muck	34,749,789 Cubic Yards
Volume of Gravel	11,240,652 Cubic Yards
Total Oz. of Gold	219,267 Ounces
Total Value at $600 Gold	131,560,200

Appendix C. Triangle valuation calculations

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
1	31	42	101	7					0.08
	32	43	82	0					0.00
	32	42	60	26					0.15
			243	33	81	11	3.00	0.41	0.08
2	31	42	101	7					0.08
	32	42	60	26					0.15
	32	41A	62	18					0.03
			222	51	74	17	2.74	0.63	0.09
3	31	42	101	7					0.08
	32	41A	62	18					0.03
	31	41	98	26					0.04
			261	51	87	17	3.22	0.63	0.05
4	31	41	98	26					0.04
	32	41A	62	18					0.03
	32	41	70	41					5.34
			230	85	77	28	2.85	1.04	1.80
5	31	41	98	26					0.04
	32	41	70	41					5.34
	32	40	86	14					0.09
			154	81	51	27	1.89	1.00	1.82
6	31	41	98	26					0.04
	31	40	99	18					0.27
	32	40	86	14					0.09
			154	58	94	19	3.48	0.70	0.13
7	32	40	86	14					0.09
	32	39A	86	21					4.94
	31	40	99	18					0.27
			271	53	90	18	3.33	0.66	1.76
8	32	39A	86	21					4.94
	32	39	86	20					0.15
	31	40	99	18					0.27
			271	59	90	20	3.33	0.74	1.78
9	32	39	86	20					
	31	40	99	18					
	31	39	93	28					
			278	64	93	21	3.44	0.78	0.21

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
10	32	39	86	20					0.15
	32	38	77	14					0.17
	31	39	93	28					0.21
			278	62	85	21	3.15	0.78	0.18
11	31	39	93	28					0.21
	31	38	92	28					0.31
	32	38	77	14					0.17
			162	70	54	23	2.00	0.85	0.23
12	32	38	77	14					0.17
	32	37A	74	11					1.09
	31	38	92	28					0.31
			243	53	81	18	3.00	0.66	0.52
13	32	37A	74	11					1.09
	32	37	74	12					0.36
	31	38	92	28					0.31
			240	51	80	17	2.96	0.63	0.59
14	31	38	92	28					0.31
	31	37	87	32					1.29
	32	37	74	12					0.36
			253	72	84	24	3.11	0.89	0.65
15	32	37	74	12					0.36
	32	36	72	19					0.48
	31	37	87	32					1.29
			243	63	81	21	3.00	0.78	0.71
16	31	37	87	32					1.29
	31	36	81	33					1.44
	32	36	72	19					0.48
			240	84	80	28	2.96	1.04	1.07
17	32	36	72	19					0.48
	32	35A	75	14					1.44
	31	36	81	33					0.48
			228	66	76	22	2.81	0.82	0.79
18	32	35A	75	14					0.44
	32	35	68	15					0.13
	31	36	81	33					1.44
			224	62	75	21	2.78	0.78	0.67
19	32	35	68	15					0.13
	31	36	81	33					1.44
	31	35	83	29					2.12
			232	77	77	26	2.85	0.96	1.23

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
20	32	35	68	15					0.13
	32	34	63	12					0.16
	31	35	83	29					2.12
			214	56	71	19	2.63	0.70	0.80
21	31	35	83	29					2.12
	31	34	78	29					0.67
	32	34	63	12					0.16
			224	70	75	23	2.78	0.85	0.98
22	32	34	63	12					0.16
	32	33A	56	11					0.08
	31	34	78	29					0.67
			197	52	66	17	2.44	0.63	0.30
23	32	33A	56	11					0.08
	32	33	56	9					0.37
	31	34	78	29					0.67
			190	49	63	16	2.33	0.59	0.37
24	31	34	78	29					0.67
	31	33	76	26					0.30
	32	33	56	9					0.37
			210	64	70	21	2.59	0.78	0.45
25	32	33	56	9					0.37
	32	32	41	9					0.10
	31	33	76	26					0.30
			173	43	58	14	2.15	0.52	0.26
26	32	32	41	9					0.10
	31	33	76	26					0.30
	31	32	69	19					0.43
			186	54	62	18	2.30	0.66	0.28
27	32	32	41	9					0.10
	32	31	52	8					0.30
	31	32	69	19					0.43
			162	36	54	12	2.00	0.44	0.19
28	32	31	52	8					0.03
	31	32	69	19					0.43
	31	31	66	13					0.23
			187	40	62	13	2.30	0.48	0.23
29	32	31	52	8					0.03
	32	30	54	8					0.03
	31	31	66	13					0.23
			172	29	57	10	2.11	0.37	0.10

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
30	32	30	54	8					0.03
	31	30	71	6					0.00
	31	31	66	13					0.23
			191	27	64	9	2.37	0.33	0.09
31	32	30	54	8					0.03
	31	30	71	6					0.00
	31	29	27	6					0.00
			152	20	51	7	1.89	0.26	0.01
32	32	43	82	0					0.00
	32	42	60	26					0.15
	33	42	78	22					0.10
			220	48	73	16	2.70	0.59	0.08
33	32	42	60	26					0.15
	33	42	78	22					0.10
	33	41	85	22					1.60
			223	70	74	23	2.74	0.85	0.62
34	33	41	85	22					1.60
	32	42	60	26					0.15
	32	41A	62	18					0.03
			207	66	69	22	2.55	0.81	0.59
35	33	41	85	22					1.60
	33	40A	85	29					3.64
	32	41A	62	18					0.03
			232	69	77	23	2.85	0.85	1.75
36	33	40A	85	29					3.64
	32	41A	62	18					0.03
	32	41	70	41					5.34
			217	88	72	29	2.66	1.07	3.00
37	33	40A	85	29					3.64
	33	40	85	33					11.98
	32	41	70	41					5.34
			240	103	80	34	2.96	1.26	6.99
38	33	40	85	33					11.98
	32	41	70	41					5.34
	32	40	86	14					0.09
			241	88	80	29	2.96	1.07	5.80
39	33	40	85	33					11.98
	33	39A	80	52					2.29
	32	40	86	14					0.09
			251	99	84	33	3.11	1.22	4.79

Tri.			Depth		Ave.	Ave.	Factors		Value
No.	Line	Hole	Muck	Gravel	Muck	Gravel	Muck	Gravel	S.F.
40	32	40	86	14					0.09
	32	39A	86	21					4.94
	33	39A	80	52					2.29
			252	87	84	29	3.11	1.07	2.44
41	33	39A	80	52					2.29
	33	39	90	31					1.34
	32	39A	86	21					4.94
			256	104	85	35	3.15	1.30	2.86
42	33	39	90	31					1.34
	32	39A	86	21					4.94
	32	39	86	20					0.15
			262	72	87	24	3.22	0.89	2.14
41A	33	39	90	31					1.34
	33	38	82	20					0.99
	32	39	86	20					0.15
			258	71	86	24	3.19	0.89	0.83
43	33	38	82	20					0.99
	32	39	86	20					0.15
	32	38	77	14					0.17
			245	74	82	25	3.03	0.93	0.44
44	33	38	82	20					0.99
	33	37	82	21					0.94
	32	38	77	14					0.17
			241	55	80	18	2.96	0.66	0.70
45	32	38	77	14					0.17
	32	37A	74	11					1.09
	33	37	82	21					0.94
			233	46	78	15	2.89	0.56	0.73
46	33	37	82	21					0.94
	32	37A	74	11					1.09
	32	37	74	12					0.36
			230	44	77	15	2.85	0.56	0.80
47	33	37	82	21					0.94
	33	36	67	13					1.69
	32	37	74	12					0.36
			223	46	74	15	2.74	0.56	1.00
48	33	36	67	13					1.69
	32	37	74	12					0.36
	32	36	72	19					0.48
			213	44	71	15	2.63	0.56	1.03

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
49	33	36	67	13					1.69
	33	35	67	18					0.91
	32	36	72	19					0.48
			206	50	69	16	2.56	0.59	1.03
50	33	35	67	18					0.91
	32	36	72	19					0.48
	32	35A	75	14					0.44
			214	41	71	13	2.63	0.48	0.61
51	33	35	67	18					0.91
	32	35A	75	14					0.44
	32	35	68	15					0.13
			210	47	70	16	2.59	0.59	0.49
52	33	35	67	18					0.91
	33	34	72	13					0.08
	32	35	68	15					0.13
			207	45	69	15	2.56	0.56	0.37
53	33	34	72	13					0.08
	32	35	68	15					0.13
	32	34	63	12					0.16
			203	40	68	13	2.52	0.48	0.12
54	33	34	72	13					0.08
	33	33	62	11					0.07
	32	34	63	12					0.16
			197	36	66	12	2.44	0.44	0.10
55	33	33	62	11					0.07
	32	34	63	12					0.16
	32	33A	56	11					0.08
			181	34	60	11	2.22	0.41	0.10
56	33	33	62	11					0.07
	32	33A	56	11					0.08
	32	33	56	9					0.37
			174	31	58	10	2.15	0.37	0.17
57	33	33	62	11					0.07
	33	32	51	7					0.00
	32	33	56	9					0.37
			169	27	56	9	2.07	0.33	0.15
58	33	32	51	7					0.00
	32	33	56	9					0.37
	32	32	41	9					0.10
			148	25	49	8	1.81	0.30	0.16

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	S.F.
59	33	32	51	7					0.00
	33	31	50	6					0.05
	32	32	41	9					0.10
			142	22	47	7	1.74	0.26	0.05
60	33	31	50	6					0.05
	32	32	41	9					0.10
	32	31	52	8					0.03
			143	23	47	8	1.74	0.30	0.06
61	33	31	50	6					0.05
	33	30	41	25					0.04
	32	31	52	8					0.03
			143	29	47	10	1.74	0.37	0.04
62	33	30	41	15					0.04
	32	31	52	8					0.03
	32	30	54	8					0.03
			147	31	49	10	1.81	0.37	0.03
63	34	42	89	0					0.00
	34	41	91	18					0.23
	33	42	78	22					0.10
			258	40	86	13	3.19	0.48	0.11
64	34	41	91	18					0.23
	33	42	78	22					0.10
	33	41	85	22					1.60
			254	62	85	31	3.15	1.15	0.64
65	34	41	91	18					0.23
	34	40	100	21					0.20
	33	41	85	22					1.60
			276	61	92	20	3.41	0.74	0.51
66	33	41	85	22					1.60
	33	40A	85	29					3.64
	34	40	100	21					0.20
			270	72	90	24	3.33	0.89	1.81
67	34	40	100	21					0.20
	33	40A	85	29					3.64
	33	40	85	33					11.98
			270	103	90	34	3.33	1.26	5.27
68	34	40	100	21					0.20
	34	39	96	18					0.36
	33	40	85	33					11.98
			281	73	94	24	3.48	0.89	4.18

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
69	34	39	96	18					0.36
	33	40	85	33					11.98
	33	39A	80	52					2.29
			261	103	88	34	3.26	1.26	4.88
70	34	39	96	18					0.36
	34	38A	90	21					0.27
	33	39A	80	52					2.29
			266	91	89	30	3.30	1.11	0.97
71	34	38A	90	21					0.27
	33	39A	80	52					2.29
	33	39	90	31					1.34
			260	104	87	35	3.22	1.30	1.33
72	34	38A	90	21					0.27
	34	38	89	31					8.00
	33	39	90	31					1.34
			269	82	90	28	3.22	1.04	3.20
73	34	38	89	31					8.00
	33	39	90	31					1.34
	33	38	82	20					0.99
			261	82	87	28	3.22	1.04	3.44
74	34	38	89	31					8.00
	34	37A	83	10					1.30
	33	38	82	20					0.99
			254	61	85	20	3.15	0.74	3.43
75	34	37	78	13					0.80
	33	38	82	20					0.99
	33	37	82	21					0.94
			242	54	81	18	3.00	0.66	0.90
76	34	37A	83	10					1.30
	34	37	78	13					0.80
	33	38	82	20					0.99
			243	53	81	18	3.00	0.66	1.03
77	34	37	78	13					0.80
	34	36	80	13					0.60
	33	37	82	21					0.94
			240	47	80	16	2.96	0.59	0.78
78	34	36	80	13					0.60
	33	37	82	21					0.94
	33	36	67	13					1.69
			229	47	76	16	2.81	0.59	1.07

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	S.F.
79	34	36	80	13					0.60
	34	35	78	13					0.94
	33	36	67	13					1.69
			225	39	75	13	2.77	0.48	0.97
80	34	35	78	13					0.63
	33	36	67	13					1.69
	33	35	67	18					0.91
			212	44	71	15	2.63	0.56	1.07
81	34	35	78	13					0.63
	34	34	78	11					0.69
	33	35	67	18					0.91
			223	42	74	14	2.74	0.52	1.07
82	34	34	78	11					0.69
	33	35	67	18					0.91
	33	34	72	13					0.08
			217	42	72	14	2.67	0.52	0.56
83	34	34	78	11					0.69
	34	33	73	13					0.17
	33	34	72	13					0.08
			223	37	74	12	2.74	0.44	0.31
84	34	33	73	13					0.17
	33	34	72	13					0.08
	33	33	62	11					0.07
			207	37	69	12	2.56	0.44	0.11
85	34	33	73	13					0.17
	34	32	65	10					0.20
	33	33	62	11					0.07
			200	34	67	11	2.48	0.41	0.15
86	34	32	65	10					0.20
	33	33	62	11					0.07
	33	32	51	7					0.00
			178	28	59	9	2.19	0.33	0.09
87	34	32	65	10					0.20
	33	32	51	7					0.00
	33	31	50	6					0.05
			166	23	55	8	2.04	0.30	0.08
88	34	32	65	10					0.20
	34	20	37	0					0.00
	33	31	50	6					0.05
			152	16	51	5	1.89	0.19	0.08

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
89	34	30	65	10					0.00
	33	31	37	0					0.05
	33	30	50	6					0.04
			152	16	42	10	1.56	0.37	0.03
90	34	30	37	0					0.00
	34	29	42	9					0.05
	33	30	41	15					0.04
			120	31	40	8	1.48	0.30	0.03
91	36	41	84	7					0.17
	36	40	86	9					0.59
	34	42	89	0					0.00
			259	16	86	5	3.19	0.19	0.24
92	36	40	86	9					0.59
	34	42	89	0					0.00
	34	41	91	18					0.23
			266	27	89	9	3.30	0.33	0.27
93	36	40	86	9					0.59
	36	39A	82	24					1.45
	34	41	91	18					0.23
			259	41	86	14	3.19	0.52	0.76
94	36	39A	82	24					1.45
	36	39	92	20					1.00
	34	41	91	18					0.23
			265	62	88	21	3.26	0.78	0.88
95	36	39	92	20					1.00
	34	41	91	18					0.23
	34	40	100	21					0.20
			283	59	94	20	3.48	0.74	0.48
96	36	39	92	20					1.00
	36	38	98	10					0.26
	34	40	100	21					0.20
			290	51	97	17	3.59	0.63	0.49
97	36	38	98	10					0.26
	34	40	100	21					0.20
	34	39	96	18					0.36
			284	49	98	16	3.63	0.59	0.27
98	36	38	98	10					0.26
	34	39	96	18					0.36
	34	38A	90	21					2.37
			284	49	95	16	3.52	0.59	1.00

Tri.			Depth		Ave.	Ave.	Factors		Value
No.	Line	Hole	Muck	Gravel	Muck	Gravel	Muck	Gravel	S.F.
99	36	38	98	10					0.26
	36	37A	94	13					1.35
	34	38A	90	21					2.37
			282	44	94	15	3.48	0.56	1.33
100	36	37A	94	13					1.35
	34	38A	90	21					2.37
	34	38	89	31					8.00
			273	65	91	22	3.37	0.81	3.91
101	36	37A	94	13					1.35
	36	37	91	13					1.13
	34	38	89	31					8.00
			274	57	91	19	3.37	0.70	3.49
102	36	37	91	13					1.13
	34	38	89	31					8.00
	34	37A	83	10					1.30
			263	54	88	18	3.26	0.66	3.48
103	36	37	91	13					1.13
	36	36	92	7					0.02
	34	37A	83	10					1.30
			266	30	89	10	3.30	0.37	0.82
104	36	36	92	7					0.02
	34	37A	83	10					1.30
	34	37	78	13					0.80
			253	30	84	10	3.11	0.37	0.71
105	36	36	92	7					0.02
	36	35A	90	8					0.21
	34	37	78	13					0.80
			260	28	87	9	3.22	0.33	0.34
106	36	35A	90	8					0.21
	34	37	78	13					0.80
	34	36	80	13					0.60
			248	34	83	11	3.07	0.41	0.54
107	36	35A	90	8					0.21
	36	35	77	10					0.16
	34	36	80	13					0.60
			247	31	82	10	3.04	0.37	0.32
108	36	35	77	10					0.16
	36	34	70	8					0.33
	34	36	80	13					0.60
			227	31	76	10	2.81	0.37	0.36

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
109	36	34	70	8					0.33
	34	36	80	13					0.60
	34	35	78	13					0.63
			228	34	76	11	2.81	0.41	0.52
110	36	34	70	8					0.33
	36	33A	70	14					0.81
	34	35	78	13					0.63
			218	36	72	12	2.67	0.44	0.59
111	36	33A	70	14					0.81
	34	35	78	13					0.63
	34	34	78	11					0.69
			226	38	75	13	2.78	0.48	0.71
112	36	33A	70	14					0.81
	36	33	64	8					0.46
	34	34	78	11					0.69
			212	33	71	11	2.63	0.41	0.65
113	36	33	64	8					0.46
	36	32	64	10					0.07
	34	34	78	11					0.69
			206	29	69	10	2.56	0.37	0.41
114	36	32	64	10					0.07
	34	34	78	11					0.69
	34	33	73	13					0.17
			215	34	72	11	2.67	0.41	0.31
115	36	32	64	10					0.07
	36	31A	52	19					0.53
	34	33	73	13					0.17
			189	42	63	14	2.33	0.52	0.26
116	36	31A	52	19					0.53
	34	33	73	13					0.17
	34	32	65	10					0.20
			171	42	63	14	2.33	0.52	0.29
117	36	31A	52	19					0.53
	36	31	54	14					0.20
	34	32	65	10					0.20
			171	43	57	14	2.11	0.52	0.31
118	36	31	54	14					0.20
	36	30	54	10					0.44
	34	32	65	10					0.20
			173	34	58	11	2.15	0.41	0.28

Tri. No.	Line	Hole	Depth Muck	Depth Gravel	Ave. Muck	Ave. Gravel	Factors Muck	Factors Gravel	Value S.F.
119	36	30	54	10					0.44
	34	32	65	10					0.20
	34	30	37	0					0.00
			156	20	32	7	1.19	0.26	0.21
120	36	30	54	10					0.44
	36	29A	45	21					0.54
	34	30	37	0					0.00
			136	31	45	10	1.67	0.37	0.32
121	36	29A	45	21					0.54
	36	29	45	16					0.93
	34	30	37	0					0.00
			127	37	42	12	1.56	0.44	0.49
122	36	29	45	16					0.93
	34	30	37	0					0.00
	34	29	42	9					0.05
			124	25	41	8	1.52	0.30	0.32
123	36	29	45	16					0.93
	36	28	21	12					0.05
	34	29	42	9					0.05
			108	37	36	12	1.33	0.44	0.35

Appendix D. Triangle valuation summary

Tri. No.	Area Sq.Ft.	Muck Factor	C.Y. Muck	Gravel Factor	C.Y. Gravel	Value Factor	Total Value*
Block D							
1	24800	3.00	74400	0.41	10168	0.08	1984
2	16400	2.74	44936	0.63	10332	0.09	1476
3	24600	3.22	79212	0.63	15498	0.05	1230
4	16200	2.85	46170	1.04	16848	1.80	29160
5	21000	1.89	39690	1.00	21000	1.82	38220
6	21000	3.48	73080	0.70	14700	0.13	2730
7	12000	3.33	39960	0.66	7920	1.76	21120
8	12800	3.33	42624	0.74	9472	1.78	22784
9	23000	3.44	79120	0.78	17940	0.21	4830
10	23000	3.15	72450	0.78	17940	0.18	4140
11	23000	2.00	46000	0.85	19550	0.23	5290
12	11500	3.00	34500	0.66	7590	0.52	5980
13	11500	2.96	34040	0.63	7245	0.59	6785
14	24000	3.11	74640	0.89	21360	0.65	15600
15	23500	3.00	70500	0.78	18330	0.71	16685
16	23000	2.96	68068	1.04	23920	1.07	24610
17	12000	2.81	33720	0.82	9840	0.79	9480
18	11000	2.76	30360	0.78	8580	0.67	7370
19	23000	2.85	65550	0.96	22080	1.23	28290
20	23000	2.63	60490	0.70	16100	0.80	28400
21	23000	2.78	63940	0.85	19550	0.98	22540
22	11500	2.44	28060	0.63	7245	0.30	3450
23	11500	2.33	26795	0.59	6785	0.37	4255
24	23000	2.59	59570	0.78	17940	0.45	20350
25	23000	2.15	49450	0.52	11960	0.26	5980
26	23000	2.30	52900	0.66	15180	0.28	6440
27	23000	2.00	46000	0.44	10210	0.19	4370
28	23000	2.30	52900	0.48	11040	0.23	5290
29	23000	2.11	48530	0.37	8510	0.10	2300
30	23000	2.37	54510	0.33	7590	0.09	2070
31	20000	1.89	37800	0.26	5200	0.01	200
	612,000 S.F. Area		1692965 C.Y. Muck		417,623 C.Y. Gravel		403,409 = 11,525 oz Gold
Block F							
32	23000	2.70	62100	0.59	13570	0.08	1840
33	23000	2.74	63020	0.85	19550	0.62	14260
34	11500	2.55	29325	0.81	9315	0.59	6785
35	11500	2.85	32775	0.85	9775	1.75	20125
36	11500	2.66	30590	1.07	12305	3.00	34500
37	11500	2.96	34040	1.26	14490	6.99	80385
38	23000	2.96	68080	1.07	24610	5.80	133400
39	11500	3.11	35765	1.22	14030	4.79	55085

TRIANGLE VALUATION COMPILATION

Tri. No.	Area Sq.Ft.	Muck Factor	C.Y. Muck	Gravel Factor	C.Y. Gravel	Value Factor	Total Value *
40	11500	3.11	35765	1.07	12305	2.44	28060
41	11500	3.15	36225	1.30	14950	2.86	32890
42	11500	3.22	27030	0.89	10235	2.14	24610
43	23000	3.03	69690	0.93	21390	0.44	10120
44	23000	2.96	68080	0.66	15180	0.70	16100
45	23000	2.89	66470	0.56	12880	0.73	16790
46	11500	2.85	32775	0.56	6440	0.80	9200
47	11500	2.74	31510	0.56	6440	1.00	11500
48	23000	2.63	60490	0.56	12880	1.03	23690
49	23000	2.56	58880	0.59	13570	1.03	23690
50	23000	2.63	60490	0.48	11040	0.61	14030
51	11500	2.59	29785	0.59	6785	0.49	5635
52	11500	2.56	29440	0.56	6440	0.37	4255
53	23000	2.52	57960	0.48	11040	0.12	2760
54	23000	2.44	56120	0.44	10120	0.10	2300
55	23000	2.22	51060	0.41	9430	0.10	2300
56	23000	2.15	49450	0.37	8510	0.17	3910
57	23000	2.07	47610	0.33	7590	0.15	3450
58	23000	1.81	41630	0.30	6900	0.16	3680
59	23000	1.74	40020	0.26	5980	0.05	1150
60	23000	1.74	40020	0.30	6900	0.06	1380
61	23000	1.74	40020	0.37	8510	0.04	920
62	23000	1.81	41630	0.37	8510	0.03	690
	598000 S.F.		1437845 C.Y. Muck		351670 C.Y. Gravel		$639490 18271 oz. Gold

Block G

Tri. No.	Area Sq.Ft.	Muck Factor	C.Y. Muck	Gravel Factor	C.Y. Gravel	Value Factor	Total Value
63	23000	3.19	73370	0.48	11040	0.11	2530
64	23000	3.15	72450	1.15	26450	0.64	14720
65	23000	3.41	78430	0.74	17020	0.51	11730
66	11500	3.33	38295	0.89	10235	1.81	20815
67	11500	3.33	38295	1.26	14490	5.27	60605
68	23000	3.48	80040	0.89	20470	4.18	96140
69	11500	3.26	37140	1.26	14490	4.88	56120
70	11500	3.30	37950	1.11	12765	0.97	11155
71	11500	3.22	37030	1.30	14950	1.33	15295
72	11500	3.33	38295	1.04	11960	3.20	36800
73	23000	3.22	74060	1.04	23920	3.44	79120
74	11500	3.15	36225	0.74	8510	3.43	39445
75	11500	3.00	34500	0.66	7590	0.90	10350
76	23000	3.00	69000	0.66	15180	1.03	23690
77	23000	2.96	68080	0.59	13570	0.78	17940
78	23000	2.81	64630	0.59	13570	1.07	24610
79	23000	2.77	63710	0.48	11040	0.97	22310
80	23000	2.63	60490	0.56	12880	1.07	24610

TRIANGLE VALUATION COMPILATION

Tri. No.	Area Sq.Ft.	Muck Factor	C.Y. Muck	Gravel Factor	C.Y. Gravel	Value Factor	Total Value *
81	23000	2.74	63020	0.52	11960	1.07	24610
82	23000	2.67	61410	0.52	11960	0.56	12880
83	23000	2.74	63020	0.44	10120	0.31	7130
84	23000	2.56	58880	0.44	10120	0.11	2530
85	23000	2.48	57040	0.41	9430	0.15	3450
86	23000	2.19	50370	0.33	7590	0.09	2070
87	22000	2.04	44880	0.30	6600	0.08	1760
88	49200	1.89	92988	0.19	9348	0.08	3936
89	23000	1.56	3588	0.37	8510	0.03	690
90	23000	1.48	34040	0.30	6900	0.03	690
	582,200		1,531,226 C.Y. Muck		352,668 C.Y. Gravel		$627731 = 17935 oz. Gold

Block H

Tri. No.	Area Sq.Ft.	Muck Factor	C.Y. Muck	Gravel Factor	C.Y. Gravel	Value Factor	Total Value *
91	33200	3.19	105908	0.19	6308	0.24	7968
92	33200	3.30	109560	0.33	10956	0.27	8964
93	16800	3.19	53592	0.52	8736	0.76	12768
94	16800	3.26	54768	0.78	13104	0.88	14784
95	34000	3.48	118320	0.74	25160	0.48	16320
96	35000	3.59	125650	0.63	22050	0.49	17150
97	35000	3.63	127050	0.53	18550	0.27	9450
98	18000	3.52	63360	0.59	10620	1.00	18000
99	18000	3.48	62640	0.56	10080	1.33	23940
100	18000	3.37	60660	0.81	14580	3.91	70380
101	18500	3.37	62345	0.70	12950	3.49	64565
102	18500	3.26	60310	0.66	12210	3.48	64380
103	37000	3.30	122100	0.37	13690	0.82	30340
104	18500	3.11	57535	0.37	6845	0.71	13135
105	18500	3.22	59570	0.33	6105	0.34	6290
106	37000	3.07	113590	0.41	15170	0.54	19980
107	25900	3.04	78736	0.37	9583	0.32	8288
108	25900	2.81	72779	0.37	9583	0.36	9324
109	37000	2.81	103970	0.41	15170	0.52	19240
110	20000	2.67	53400	0.44	8800	0.59	11800
111	39000	2.78	108420	0.48	18720	0.71	27690
112	17200	2.63	45236	0.41	7052	0.65	11180
113	39000	2.56	99840	0.37	14430	0.41	15990
114	40000	2.67	106800	0.41	16400	0.31	12400
115	23000	2.33	53590	0.52	11960	0.26	5980
116	40000	2.33	93200	0.52	20800	0.29	11600
117	18000	2.11	37980	0.52	9360	0.31	5580
118	41000	2.15	88150	0.41	16810	0.28	11480
119	84000	1.19	99960	0.26	21840	0.21	17640
120	21000	1.67	35070	0.37	7770	0.32	6720

TRIANGLE VALUATION COMPILATION

Tri. No.	Area Sq.Ft.	Muck Factor	C.Y. Muck	Gravel Factor	C.Y. Gravel	Value Factor	Total Value
121	21000	1.56	32760	0.44	9240	0.49	10290
122	43000	1.52	65360	0.30	12900	0.32	13760
123	43000	1.33	57190	0.44	18920	0.35	15050
	998,000		2,589,399 C.Y. Muck		436,452 C.Y. Gravel		$612426 17498 oz. Gold

Summary of Triangle And Double-end
Valuation Results For Blocks D, F, G & H

	Block D	Block F	Block G	Block H
Muck Volume				
Triangle	1,692,965	1,437,845	1,531,226	2,589,399
Double End	1,727,467	1,465,185	1,495,777	2,569,666
Gravel Volume				
Triangle	417,623	351,670	352,668	436,452
Double End	421,912	371,621	382,444	468,000
Total Oz. Gold				
Triangle	11,525	18,271	17,935	17,498
Double End	13,251	19,224	17,391	17,093
Oz./C.Y. Gravel				
Triangle	0.0276	0.520	0.0508	0.0401
Double End	0.0314	0.0517	0.0480	0.0365
Area S.F.	612000	598000	582200	998000

Appendix E. Computer isopach valuation calculations

Block D, G, H, F

Muck Thickness — $\text{Inch}^2 = 40{,}000\ ft^2$

Isopach Value	Area (in^2)	Area (ft^2)
10'	68.79	2751600
20'	68.79	2751600
30'	68.69	2747600
40'	68.79 - 2.11 =66.68	2667200
50'	58.81	2352400
60'	50.50	2020000
70'	38.82	1552800
80'	22.32	892800
90'	6.63 + .66 =7.29	291600

W/O Loading

Total Area of Isopacks	18027600 ft^2
Isopach Thickness	10 ft
Total Volume Muck	180276000 ft^3
Total Volume Muck (yd^3)	6676889 yd^3

With Loading

Loading Factor 2751600 x 10/2	13758000 ft^3
Total Volume W/Loading 180276000 + 13758000	194034000 ft^3
Total Volume Muck	7186444 yd^3

COMPUATER ISOPACH VALUATION

Gravel Thickness $\qquad$ 1 inch^2 = 40,000 ft^2

Isopach Value	Area (Inch^2)	Area (Ft^2)
0'	68.79	2751600
4'	68.37-.88 = 67.49	2734800
8'	68.79-1.80 -.72-5.24-.23 = 60.8	2432000
12'	68.79-0.10 -5.95-.32 -11.92-.96 -3.04-.30 = 46.20	1848000
16'	68.79-33.81 -5.91-.21 = 28.86	1154400
20'	68.79-0.15 +0.09-.05 -40.34-8.04 = 20.4	816000
24'	3.11 + 8.42 = 11.53	461200
28'	0.90 + 4.82 = 5.72	228800
32'	0.08 + 2.53 = 2.61	104400
36'	0.42 + 0.89 = 1.31	52400
40'	0.26	10400
44'	0.10	4000

Without Loading

Total Area of All Isopachs	9846400 ft^2
Thickness Per Isopach Unit	4 ft
Total Volume Gravel (ft^3)	39385600 ft^3
Total Volume Gravel (yd^3)	1458725 yd^3

With Loading

Gravel Loading Factor, 2751600 x 4/2	5503200 ft^3
Total Volume W/Loading, 39385600 + 5503200	44888800 ft^3
Total Volume Gravel	1,662,548 yd^3

COMPUTER ISOPACH VALUATION

Total Value of Gold

$Inch^2 = 40,000\ ft^2$

\$/S.F. Isopach Value	Area ($Inch^2$)	Area (Ft^2)
0.40	68.79 - 22.71 - .62 - 6.39 = 39.05	1562000
0.80	68.79 - 38.10 - 6.13 = 24.56	982400
1.20	68.79 - 44.24 - 8.62 = 15.93	637200
1.60	11.11	444400
2.00	8.11	324400
2.40	6.22	248800
2.80	4.62	184800
3.20	3.93	157200
3.60	3.42	136800
4.00	2.70	108000
4.40	2.04	81600
4.80	1.70	68000
5.20	1.18	47200
5.60	0.93	37200
6.00	0.72	28800
6.40	0.63	25200
6.80	0.41	16400
7.20	.22	8800
7.60	.18	7200
8.00	.14	5600
8.40	.08	3200
8.80	.04	1600
9.20	.02	800
9.60	.01	400

Total Value of Gold (cont)

Without Loading Factor

Total Area of Isopachs (Ft^2)	5118000 ft^2
Isopach Thickness in \$35 Gold/ft^2	\$ 0.40/ft^2
Isopach Thickness in Oz. Gold/ft^2	0.01143 Oz/ft^2
Total Value of Block	58499 Oz. Gold

With Loading Factor

Loading Factor 1562000 x 0.01143/2	8927
Prior Value of Block	58,499
Total Value of Block	67,425.5

COMPUTER ISOPACH VALUATION

"Orebody" Valuation $1''^2 = 40,000$ S.F.

Total Value of Gold

Isopach Value $/S.E.	Area (Inch^2)	Area (Ft^2)
0.40	22.69	907600
0.80	22.69	907600
1.20	15.38	615200
1.60	11.11	444400
2.00	8.11	324400
2.40	6.22	248800
2.80	4.62	184800
3.20	3.93	157200
3.60	3.42	136800
4.00	2.70	108000
4.40	2.04	81600
4.80	1.70	68000
5.20	1.18	47200
5.60	0.93	37200
6.00	0.72	28800
6.40	0.63	25200
6.80	0.41	16400
7.20	0.22	8800
7.60	0.18	7200
8.00	0.14	5600
8.40	0.08	3200
8.80	0.04	1600
9.20	0.02	800
9.60	0.01	400

Total Value of Gold (Orebody) (cont.)

Without Loading Factor

Total Area of Isopachs Listed	4366800 ft^2
Isopach Thickness at \$35/Gold/ft^2	\$0.40/ft^2
Isopach Thickness in oz/ft^2	0.01143 oz/ft^2
Total Value of Orebody	49912.5 oz.

With Loading Factor

Loading Factor (907600 x 0.01143)½	5186.9
Prior Value of Block	49912.5
Total Value of Orebody	55099.4 oz.

COMPUTER ISOPACH VALUATION

"Orebody" Valuation $1 \text{ Inch}^2 = 40{,}000$ S.F.

Total Volume of Muck

Isopach Value Ft	Area (Inch^2)	Area (Ft^2)
10	22.69	907600
20	22.69	907600
30	22.69	907600
40	22.69	907600
50	22.69	907600
60	22.69	907600
70	22.69-1.42 = 21.27	850800
80	15.63	625200
90	474 + 0.92 = 5.66	226400

Total Area of Isopachs Listed	7148000 ft^2
Isopach Thickness	10 ft
Unloaded Volume of Muck	7148000 ft^3
Loading Factor (907600 x 10)½	4538000 ft^3
Total Volume Muck (ft^3)	76018000 ft^3
Total Volume Muck (yds^3)	2815481 yd^3

COMPUTER ISOPACH VALUATION

"Orebody" Valuation

Total Volume of Gravel

Isopach Value (ft)	Area (Inch^2)	Area (ft^2)
4	22.69	907600
8	22.69	907600
12	21.82	872800
16	18.58	743200
20	14.29	571600
24	8.72	348800
28	4.84	193600
32	2.59	104200
36	1.31	52400
40	0.26	10400
44	0.10	4000

Total Area of Isopachs Listed	4716200 ft^2
Isopach Thickness	4 ft
Unloaded Volume of Gravel	18864800 ft^3
Loading Factor (907600 x 4)½	1815200 ft^3
Total Volume of Gravel (ft^3)	20680000 ft^3
Total Volume of Gravel (yd^3)	765926 yd^3

TRIANGLE VALUATION

"Orebody" Valuation

Cutoff at $0.80/S.F., Referenced at $35 Gold

Triangle Number	Area S.F.	C.Y. Muck	C.Y. Gravel	Total Value Gold *
4	16200	46170	16848	29160
5	21000	39690	21000	38220
7	12000	39960	7920	21120
8	12800	42624	9472	22784
35	11500	32775	9775	20125
36	11500	30590	12305	34500
37	11500	34040	14490	80385
38	23000	68080	24610	133400
39	11500	35765	14030	55080
40	11500	35765	12305	28060
41	11500	36225	6440	32890
42	11500	37030	6440	24610
46	11500	32775	12880	9200
47	11500	31510	13570	11500
48	23000	60490	10235	23690
49	23000	58880	14490	23690
66	11500	38295	20470	20815
67	11500	38295	14490	60605
68	23000	80040	20470	96140
69	11500	37140	14490	56120
70	11500	37950	12765	11155
71	11500	37030	14950	15295
72	11500	38295	11960	36800
73	23000	74060	23920	79120
74	11500	36225	8510	39445
75	11500	34500	7590	10350
76	23000	69000	15180	23690
78	23000	64630	13570	24610
79	23000	63710	11040	22310
80	23000	60490	12880	24610
81	23000	63020	11960	24610
98	18000	63360	10620	18000
99	18000	62640	10080	23940
100	18000	60660	14580	70380
101	18500	62345	12950	64565
102	18500	60310	12210	64380
103	37000	122100	13690	30340

Total Surface Area	615,500 S.F.
Total Muck	1,866,464 C.Y.
Total Gravel	485,410
Total Value Gold	$1,412,694 @ $35/oz.
	= 40363 Oz. Gold

Appendix F. Capital cost requirements

Underground Plant and Equipment Cost Summary

Number	Item	Cost
3	Jumbo drills-dual arms, complete with silencer - 10' + 10% freight + 20% winterizing (Ingersoll-Rand, phone quote, 1980)	214,500
3	Load-haul dump units, 5 c.y. + 10% freight + 20% winterizing (Joy Equipment, phone quote 1980)	486,000
3	Low profile 35 c.y. rear dump truck + 10% freight + 20% winterizing (D.J.B. Sales Inc., phone quote 1980)	692,086
2000'	Compressed air line - 4" with victaulic couplings (Bottge, 1973)	50,000
1	Surge bin with hydraulics	10,000
2500'	Insulated water line - 2" with victaulic couplings (Bottge, 1973)	50,000
2	Booster fans (16") (Jeffry phone quote, 1980)	23,000
2	Airflow regulators	5,000
1	Electric distribution network (Bottge, 1977)	15,000
1	Telephone intercom system	5,000
1	Permacrete spray system	10,000
1	Drill steel & spare bits, air hoses (Bottge, 1977)	10,000
1	Hand tools, pumps (portable)	15,000
1	Stoper - 31" feed (Bottge, 1977)	6,000
1	Anfo loading system	2,000
	Subtotal	1,619,586
	+ 15% contingency	242,937
	TOTAL	$1,862,523

Surface Plant and Equipment Cost Summary

Number	Item	Cost
2	92" dual exhaust fan system on shaft outtake 4-8000 cfm (Jeffry Equipment, phone quote, 1980)	90,000
1	800 cfm water cooled compressor with 5x10 ft receiver (Craig-Tayler, phone quote, 1980)	70,000
400'	4" surface piping	3,000
2000'	Surface wiring	5,000
1	Mine office lamp and change room 20x30 ft. @ $60/sf	36,000
1	Office Equipment and Furniture	3,000
1	Machine shop and repair shop 40x50' @ $60/sf (Botte, 1977)	120,000
1	Shop equipment and tools, hoists, welders, etc.	60,000
1	Warehouse, 40x50' @$40/sf	80,000
1	Explosives magazine 10x25' @ $40/sf (Botte, 1977)	10,000
1	Wash plant including water facilities, trommel, tables or boxes FOB-Livengood	75,000
1	D-6 dozer w/straight blade (N.C. Machinery, phone quote, 1980)	120,000
1	966 front end loader (N.C. Macninery, phone quote, 1980)	120,000
	Service vehicles - used, surplus forklift, fuel truck, utility trucks, snow-cats, hoist truck, lube truck	90,000
	Utility vehicles, 4 - 3/4 ton pickups	40,000
	Surface Drill Percussion (The Drilling Company, phone quote, 1980)	55,000
Subtotal		987,000
Contingency @ 15%		148,050
TOTAL		$1,135,050

MINE DEVELOPMENT COST

Item			Cost
Inclined Ramp	25 meter ^{2} face		
Excavation	$121.3/foot		
*Support Materials	$98/foot		
Support Installation	$60/foot		
Total Cost	$279/foot		
15% Slope 935'			261,145
Surface Ramp Segment			
Excavation	$50/foot		
*Support Materials	$190/foot		
Installation	$60/foot		
Total Cost	$300/ft	@ 150'	45,000
Ramp Entry Development			20,000
Haulage			
No Supports - 25 meter ^{2} Face			
$142/foot @ 1350'			191,700
Shaft Auger Hole System, Culvert, Lined			
$250/foot for 6' - 100'			25,000
Booster Ventilation Shaft, 36"-100'			5,500
Summer Refrigeration Unit			20,000
Load-Haulage Point Excavation			25,000
Drill Holes for Booster Fan 1000' @ $25/foot			25,000
Subtotal			618,345
Contingency @ 15%			92,751
TOTAL			$711,097

* U.S. Gypsum, Bernoid Forming/Reinforcing System, Phone Quote, 1980

SUPPORT FACILITIES COST

Item	Cost
Townsite, 48 employees, 12 trailers Inc. Sanitation, Mess Hall	260,000
Generating Plant	
300 kw unit	60,000
40 kw backup unit	10,000
Housing	10,000
Wiring, Switches	8,000
(N-C Machinery Phone Quote, 1980)	
50,000 Gallon Diesel Tank	70,000
1500 Gallong Gasoline Tank	3,000
Surface Clearing - Roadwork	30,000
Well Drilling & Casing for Water, Pumps	15,000
Subtotal	466,000
Contingency @ 15%	69,900
TOTAL	$535,900

WORKING CAPITAL

3 months of winter operations

Item	Cost
Direct Labor	428,175
Payroll Overhead	149,861
Operating & Maintenance Supplies	457,985
Indirect Cost	114,801
Fixed Cost (0.25% of Base)	11,198
Spare Parts & Inventory	260,000
Misc Expense (10% Operating Supplies)	45,798
TOTAL	$1,407,818

Appendix G. Required operating costs

A. Operating & Maintenance Supplies

From: Cost Reference Guide For Construction Equipment, 1979

Explanation of Cost Headings and Assumed Percentage Increases

Overhaul Repair Parts - Parts & Supply Costs for Reconditioning Small Components & Rebuilding Major Components plus 30% for Inflation and Transport to Livengood

Operating Parts & Supplies - Small Items for Field Maintenance & Supplies plus 30% for Inflation and Transport to Livengood

Fuel - F.O.B. Livengood
Diesel $1.20/gallon
Gasoline $1.40/gallon
Plus 135%

Lube - 30-w, 90-w, Hydraulic @ $3.20/gallon
Grease @ 60¢/lb.
Plus 100%

Tires Plus 40% for Inflation and Transport, Recapping Not Assumed

Average Operating Costs for Required Mining and Support Equipment

Equipment Type 4 Specs.	Overhaul Maint. Parts & Supplies	Operating Costs Per Hour				Total Hourly Cost
		Parts & Supplies	Fuel (F Applic.)	Lube	Tires	
Compressor 800 cfm Unsilenced	3.86	1.70	4.96	2.02		12.54
DRILLS						
Jumbo Drifter 4 1/2" Bore, Screw Feed(10')	0.59	0.40	-	0.16	-	
Positioner Tunnel 5' Extension	0.09	0.05	-	0.02	-	
Jumbo Carriers (Severe Service) Rubber-Tired, Electric	3.71	1.82	-	0.94	0.17	
Jibs (Hydraulic Rooms) Rotation	0.53	0.52	-	0.14	-	
Silencer	0.01	0.01	-	0.02	-	
Total Assuming 2 Legs	6.14	3.77	-	1.62	0.17	11.70

Equipment Type 4 Specs.	Overhaul Maint. Parts & Supplies	Operating Costs Per Hour				Total Hourly Cost
		Parts & Supplies	Fuel (F Applic.)	Lube	Tires	
966 Front End Loader (Wheel)	3.08	3.42	7.75	1.70	2.25	18.50
D-6 D Dozer	2.38	2.38	6.39	1.26	-	
Semi-U Blade	0.22	0.22	-	0.04	-	
Total Dozer	2.49	2.49	6.39	1.30	-	12.67
LHD Wagner 5 c.y. ST-5E	4.05	6.70	8.20	2,00	6.20	27.15

Equipment Type and Specifications	Overhaul Maintenance Supplies	Operating Costs Per Hour: Parts & Supplies	Fuel (if appl)	Lube	Tires	Total Hourly Cost
Off Highway Rear Dump 35 Tons, 23 yd^3 Struck	4.16	5.59	15.79	3.12	6.15	34.81
SHOP TOOLS						
Welding	0.09	0.02	-	0.01	0.02	
Hot Cleaner	0.19	0.07	0.04	0.02	0.02	
All Hand Tools	0.09	0.05	-	-	-	
Chain Hoist (Elect)	0.13	0.03	-	0.01	-	
Misc. Shop Tools	0.18	0.09	-	0.02	-	
TOTAL	0.68	0.26	0.04	0.06	0.03	1.07
Oil Heaters (shop) 600,000 BTU	0.12	0.04	8.00	0.39	-	
(Office/Dry Room) 600,000 BTU	0.12	0.04	8.00	0.39	-	
Lighting - Mine	0.13	0.29	-	-	-	
TOTAL	0.37	0.37	16.00	0.78	-	17.52
TRUCKS						
4x4 Conventional	0.18	0.33	8.93	0.84	0.10	
4x4 Crew-Cab	0.18	0.33	9.61	0.92	0.11	
TOTAL	0.36	0.66	18.54	1.76	0.21	21.53
WATER						
Pump 4"	0.72	0.19	-	0.18	-	
Pump 1"	0.13	0.02	0.20	0.04	0.01	
TOTAL	0.85	0.21	0.20	0.22	0.01	1.49

Equipment Type and Specifications	Overhaul Maintenance Parts & Supplies	Operating Costs Per Hour: Parts & Supplies	Fuel (if Appl)	Lube	Tires	Total Hourly Cost
SERVICE VEHICLES						
Fork Lift (10 ton)	0.46	0.77	5.03	0.98	0.46	
Hoist Truck (4x4)	0.31	0.56	5.55	1.12	1.18	
Fuel Truck (4x4)	0.31	0.56	5.55	1.12	1.18	
Snow Cat	0.38	0.79	5.83	0.74	-	
Flatbed (2 ton)	0.11	0.23	8.34	0.88	1.00	
TOTAL	1.57	2.91	30.30	4.84	3.82	43.44
SUMMER WASH PLANT						
Screen	0.84	0.56	2.04	0.63	-	
Sluice (est)	0.05	0.05	-	0.01	-	
Dump (10")	2.43	0.95	3.76	0.66	0.28	
Misc.	0.30	0.10	0.30	0.10	0.05	
TOTAL	3.62	1.66	6.10	1.40	0.33	13.11
CAMP-LIVING						
150,000 BTU Oil Heaters	0.04	0.01	2.42	0.22	-	
12'x56' Trailers	0.24	0.35	0.10	-	-	
TOTAL	0.28	0.36	2.52	0.22	-	3.38

WINTER SEASON

AVERAGE HOURS OPERATION PER SEASON

150 Working Days

Load-Haul Dump Units	2x18x150	=	5400
Low Profile Trucks	2x18x150	=	5400
Complete Jumbo System	2x18x150	=	5400
Fan System	(24+4)x180	=	5000
Compressor	20x150	=	3000
D-6 Dozer	4x150	=	600
Front End Loader	7x150	=	1050
Shop Tools	20x150	=	3000
Oil Heaters/Light	1.5x24x180	=	6480
Utility Trucks	3x150	=	450
Service Trucks	4x150	=	600
Water System	24x180	=	4320
Camp	12x24x180	=	51840

SUMMER SEASON

150 Working Days

Wash Plant	20x60	=	1200
Front End Loader	14x60	=	840
Dozer	14x60	=	840
Shop Tools	20x150	=	3000
Oil Heaters/Light	5x60	=	300
Utility Trucks	3x150	=	450
Service Trucks	4x150	=	600
Water System	4x150	=	600
Camp	8x180	=	1440

ADDITIONAL COSTS

Surface Drilling @ $20/ft
Explosives
Camp Costs

B. ADDITIONAL OPERATING & MAINTENANCE SUPPLIES

From: Capital and Operating System Estimating System Handbook, 1978

1. Camp Operations - Food & Cooking

   +25% Inflation Increase

   +50% Livengood Increase (Grybeck, 1976)

   +35% Winter Diet Increase

   +105% Camp Cost Increase

   $12/person/day = $576/day

2. General Items - Sanitation, Communication, Housekeeping, Fire Protection and Electrical Supplies

   +105% Cost Increase

   $4.1/person/cay = $200/day

3. Mining Supplies
   Assume Soft Rock & Pillar

   +25% Inflation

   +20% Freight to Livengood - small items

   +35% Total Cost Increase

   Drill Steel $40/day

   Rock Bolts $25/day

   Explosives

   0.136 lbs/cubic foot mined in frozen gravel (Dick, 1973)

   1740 lbs ANFO/day @35¢/lb (Yukon Equipment, Phone Quote, 1980)

   = $609/day

   Total Mine Supplies $674/day

Power Requirements & Costs

Winter Season

Mine:

197 HP = 148KWx20hr/day
= 4780 KW-hr/dayx150 days — 443,250 KW-hr

Support:

48 People x 7.5KW-hr/day
150 days — 54,000 KW-hr

Total Power Requirements — 497,250 KW-hr

(497250 KW-hr/season)/(3000 hr/season) = 166 KW
300 KW Generator Requirement

(497250 KW-hr/season)/(13 KW-hr/gallon)
= 38,250 gallons/season

Winter Operating Cost

Fuel
38,250 Gallons x $1.30/gallong = $49,725

Maintenance
$20/ KWx 300kw (Bottge, 1977) = $ 6,000

Total Winter Operating Cost — $55,725

Cost of Power

($55,725)/(497,250KW-hr/season) = $0.11/KW-hr

Power Requirements and Costs

Summer

Washing:	
15 hp = 11KWx10hr/day x 60 days/season	6600 KW-hr
Support - Washing Period:	
16 People x 7.5 KW-hr/day x60 days/season	7200 KW-hr
Subtotal for Maximum Usage	7860 KW-hr
Support - Maintenance Period	
9 People x 7.5 KW-hr/day x 90 days	6075 KW-hr
Total Power Requirements	13,935 KW-hr

(7860 KW-hr/washing)/(600 hr/washing)
+ (6075 KW-hr/Maintenance)/(900 hr/maint.) = 19.85 KW

(13935 KW-hr/season)/(13 KW-hr) = 1072 Gallons

Operating Cost

Fuel 1072 Gallons x $1.30/gallon =	$1394
Maintenance $20/ KW x 40 dw (Bottge, 1977) =	$800
Total Operating Costs	$2194

Cost of Power

($2194)/(13935 KW- hr) = $0.16/KW-hr

Annual Cost of Water $6437/year

DIRECT COST SUMMARY - WINTER SEASON

OPERATING & MAINTENANCE SUPPLIES

Per Winter Season

Equipment or Supply Type	Mine	Support
Compressor	10,629	-
Jumbo Drill System	63,180	-
966 Front-End Loader	19,425	-
D-6 Dozer	3,801	3,801
L-H-D Units	146,610	--
Low Profile Truck	187,974	-
Shop Tools	-	3,210
Oil Heaters	-	30,876
Service Trucks	6,459	6,459
Utility Vehicles	-	19,548
Camp w/o Food	-	175,219
Food & Cooking	-	103,680
General Items	12,000	24,000
Mining Supplies	101,100	-
Subtotal	551,178	366,793
Total		$917,971

Power & Water		
Electricity	48,759	6,965
Water	3,218	3,218
Subtotal	51,977	10,183
Total		$62,160

DIRECT COST SUMMARY - SUMMER SEASON

OPERATING & MAINTENANCE SUPPLIES

Per Summer Season

Equipment or Supply Type	Mine	Support
Wash Plant	15,732	-
Front-End Loader	15,540	-
Dozer	5,321	5,321
Shop Tools	210	3,000
Oil Heater/Light	-	5,256
Utility Trucks	2,422	7,266
Service Trucks	-	19,548
Camp w/o Food	-	4,867
Food & Cooking	-	17,280
General Items	-	5,904
Mining Supplies	-	-
Subtotals	39,225	68,442
Total		107,667

Power & Water		
Water	894	-
Power	1,097	1,097
Subtotals	1,991	1,097
Total		3,088

GENERAL MANNING TABLE - WINTER

Winter @ 180 Days (Incl. Sunday)

JOB	Shifts Day	Shifts Night	Man-Shifts Per Day	** Wages Per Man-Hour	* Wages Per Day	*** Work Days Per Season	Salaried $ Per Day	Total Seasonal Cost	
PRODUCTION/DEVELOPMENT:									
Drillers	2	2	4	13.50	157.5	154	-	97,020	
Miners	3	3	6	13.50	157.5	154	-	145,530	
LHD Operators	2	2	4	13.50	157.5	154	-	97,020	
Truck Haulage	2	2	4	13.50	157.5	154	-	97,020	
Surface Optr.	1	0	1	12 00	140.0	154	-	21,560	
Subtotal									458,150
SUPPORT:									
Lineman	1	1	2	11.00	127.6	154	-	39,300	
Elect/Vent.	1	1	2	13.50	157.5	154	-	48,510	
Mechanics	1	1	2	14.00	163.2	154	-	50,265	
Welder	1	1	2	13.50	157.5	154	-	48,510	
Gen. Maint.	2	1	3	10.80	125.9	154	-	58,178	
Cooks	1	1	2	13.00	151.58	154	-	46,686	
Cooks Helpers	1	1	2	10.00	116.60	154	-	35,912	
Subtotal									327,361
SUPERVISORY:									
Shift Sup'visor	1	1	2	-	-	154	160	49,280	
Engineers	1	0	1	-	-	154	140	21,560	
Subtotal									70,840

General Manning Table (cont.)

JOB	Shifts Day	Shifts Night	Man-Shifts Per Day	** Man-Shifts Man-Hour	* Wages Per Day	*** Work Days Per Season	Salaried $ Per Day	Total Seasonal Cost	
ADMIN, TECH CLERICAL:									
Survey/Samplers	2	0	2	-	-	154	120	36,960	
Clerk/Payroll	2	0	2	-	-	129	120	30,857	
Mine Manager	1	0	1	-	-	129	180	23,143	
Subtotal			45						90,959
TOTAL									947,310

* 60 Hours Per Week Translates to 1.66 Hours Per Day in Overtime Compensation
** Night Shift Differential Averaged Into Tabulated Wage Rate
*** 6 Days Per Week, Production Wages Reflect Additional Production Bonuses

GENERAL MANNING TABLE - SUMMER

JOB	Shifts Day	Shifts Night	Man-Shifts Per Day	Wages Per Man-Hour	Wages Per Day	Work Days Per Season	Salaried $ Per Day	Total Seasonal Cost	
PRODUCTION:									
Equipment Operators	2	0	2	14.00	163.24	60	-	19,588	
Wash-Man	1	0	1	14.00	163.24	60	-	9,794	
Wash-Helpers	2	0	2	10.00	116.60	60	-	13,992	
Subtotal									43,374
SUPPORT:									
Mechanic	1	0	1	14.00	163.24	120	-	19,588	
Welder	1	0	1	14.00	163.24	120	-	19,588	
Mech. Helper	2	0	2	10.00	116.60	120	-	27,984	
Maint. Men	2	0	2	12.00	139.92	150	-	41,976	
Night Watchmen	0	1	1	12.00	139.92	150	-	20,988	
Cook	1	0	1	12.00	139.92	150	-	20,988	
Subtotal									151,114
SUPERVISORY:									
Mine Supervisor	1	0	1	-	-	120	160	19,200	
Subtotal									19,200
ADMIN. TECH. CLERICAL:									
Clerk/Payroll	2	0	2	-	-	120	120	28,800	
Mine Manager*						-	-	-	
Subtotal									28,800
TOTAL									$242,488

*Salary Allocation from Summer Budget Operation

Appendix H. Cash flow calculations

COST SUMMARY FOR CASH FLOW & FEASIBILITY

Year 1 - CAPITAL COST

$6,111,367

Years 2-6 - OPERATING COST

Winter	$2,432,300
Summer	524,469
Total Annual	$2,956,769

Annual Depreciation $940,708

Annual Depletion (Choose Larger)

Cost Depletion:

268918 yds^3 Mined in 5 years

Exploration & Acquisition Costs = 235,000

.20 (235,000) = $47,000/year

Statutory Depletion: (Choose Smaller)

a) 15% x Gross Revenue

b) 50% x Net Revenue After Royalty

Taxes

Federal Income Tax 46%

State Income Tax 8%

State Mining License Tax

(Taxable Income Minus 100,000)(x7%) (+ $4000)
First 3 Years Grace Period

Royalty

7% of Net Income, Subtracted prior to depletion and Depreciation

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	3064693
Operating Costs	2956769
Net Income	107924
7% Royalty	7554
Depreciation	940708
Net Profit	(840338)
Depletion	-
Taxable Profit	(840338)
Federal & State Tax	-
State Mining Tax	-
Net After Taxes	(840338)
Add Depreciation	940708
Add Depletion	-
NET CASH FLOW	100,369

PRICE OF GOLD PER OUNCE - $450.00

Three	Four	Five	Six
3955366	3656719	4166848	3629170
2956769	2956769	2956769	2956769
998597	699950	1210079	672401
69901	48996	84705	47068
940708	940708	940708	940708
(12012)	(289754)	184665	(315375)
-	-	92332	-
(12012)	(289754)	92332	(315375)
-	-	49859	-
-	-	3800	-
(12012)	(289754)	38672	(315375)
940708	940708	940708	940708
-	-	92332	-
928,695	650,953	1,071,712	625,332

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	3742942
Operating Costs	2956769
Net Income	786173
7% Royalty	55032
Depreciation	940708
Net Profit	(209567)
Depletion	-
Taxable Profit	(209567)
Federal & State Tax	-
State Mining Tax	-
Net After Taxes	(209567)
Add Depreciation	940708
Add Depletion	-
NET CASH FLOW	731,140

PRICE OF GOLD PER OUNCE - $550.00

Three	Four	Five	Six
4879355	4466019	5089048	4432370
2956769	2956769	2956769	2956769
1922585	1509250	2132279	1475601
134581	105647	149259	103292
940708	940708	940708	940708
847296	462894	1042311	431600
423648	231447	521155	215800
423648	231447	521155	215800
115604	124981	281424	116532
-	-	33480	12106
308044	93264	206250	87162
940708	940708	940708	940708
423648	231447	521155	215800
1,672,400	1,278,621	1,668,114	1,243,670

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	4086257
Operating Costs	2956769
Net Income	1129488
7% Royalty	79064
Depreciation	940708
Net Profit	109715
Depletion	54857
Taxable Profit	54857
Feder & State Tax	29623
State Mining Tax	-
Net After Taxes	25234
Add Depreciation	940708
Add Depletion	54857
NET CASH FLOW	1,020,800

PRICE OF GOLD PER OUNCE - $550

Three	Four	Five	Six
5270821	4875625	5555797	4838893
2956769	2956769	2956769	2956769
2314052	1918856	2599028	1882124
161983	134319	181932	131748
940708	940708	940708	940708
1211360	843829	1476388	809667
605680	421914	738194	404833
605680	421914	738194	404833
327067	227833	398624	218610
-	-	48673	25338
278612	194080	290896	160885
940708	940708	940708	940708
605680	421914	738194	404833
1,825,001	1,556,703	1,969,798	1,506,426

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	4256518
Operating Costs	2956769
Net Income	1299749
7 % Royalty	90982
Depreciation	940708
Net Profit	268058
Depletion	134029
Taxable Profit	134029
Federal & State Tax	72375
State Mining Tax	-
Net After Taxes	61653
Add Depreciation	940708
Add Depletion	135029
NET CASH FLOW	1,136,391

PRICE OF GOLD PER OUNCE - $625

Three	Four	Five	Six
5496563	5078776	5787288	5040513
2956769	2956769	2956769	2956769
2539794	2122007	2830519	2083744
177785	148540	198136	145862
940708	940708	940708	940708
1421300	1032758	1691674	997173
710650	516379	845837	498586
710650	516379	845837	498586
383751	278844	456752	269236
-	-	56208	31901
326899	237534	332876	197448
940708	940708	940708	940708
710650	516379	845837	498586
1,978,257	1,694,621	2,024,551	1,636,742

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	4421191
Operating Costs	2956769
Net Income	1464422
7% Royalty	102509
Depreciation	940708
Net Profit	421204
Depletion	210602
Taxable Profit	210602
Federal & State Tax	113725
State Mining Tax	-
Net After Taxes	85135
Add Depreciation	940708
Add Depletion	210602
NET CASH FLOW	1,248,187

PRICE OF GOLD PER OUNCE - $650

Three	Four	Five	Six
5706082	5275319	6011248	5235570
2956769	2956769	2956769	2956769
2749313	2318550	3054479	2278801
192451	162298	213813	159516
940708	940708	940708	940708
1616153	1215544	1899957	1178576
808076	607772	901687	589288
808076	607772	998270	589288
436361	328196	539065	318215
-	-	66878	38250
318150	240031	392326	232823
940708	940708	940708	940708
808076	607772	901687	589288
2,120,502	1,828,055	2,234,721	1,762,819

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	5099440
Operating Costs	2956769
Net Income	2142671
7% Royalty	149986
Depreciation	940708
Net Profit	1051976
Depletion	525988
Taxable Profit	525988
Federal & State Tax	284033
State Mining Tax	-
Net After Taxes	212135
Add Depreciation	940708
Add Depletion	525988
NET CASH FLOW	1,708,650

PRICE OF GOLD PER OUNCE - $750

Three	Four	Five	Six
6581440	6084619	6933448	6038770
2956769	2956769	2956769	2956769
3624671	3127850	3976679	3082001
253726	218949	278367	215470
940708	940708	940708	940708
2430236	1968192	2757604	1925552
987216	912692	1040017	905815
1443020	1055499	1717587	1019737
779230	569969	927496	550658
-	-	117231	68361
565778	414645	672859	400697
940708	940708	940708	940708
987216	912692	1040017	905815
2,591,713	2,338,929	2,653,584	2,247,220

PRODUCTION CASH FLOW

Year	Two
Gross Revenue	6873573
Operating Costs	2956769
Net Income	3916804
7% Royalty	274176
Depreciation	940708
Net Profit	2701919
Depletion	1031035
Taxable Profit	1670883
Federal & State Tax	902277
State Mining Tax	-
Net After Taxes	654644
Add Depreciation	940708
Add Depletion	1031035
NET CASH FLOW	2,740,348

PRICE OF GOLD PER OUNCE - $1000

Three	Four	Five	Six
8769835	8107869	9238948	8046770
2956769	2956768	2956769	2956769
5813066	5181100	6282179	5090001
406914	362677	439752	356300
940708	940708	940708	940708
4465443	3877715	4901718	3792992
1315475	1216180	1385842	1207015
3149968	2661534	3515876	2585977
1700982	1437228	1878573	1396427
-	-	243111	178018
1231488	836076	1394191	1011532
940708	940708	940708	940708
1315475	1216180	1385841	1207015
3,705,168	3,381,194	3,720,740	3,159,255

Appendix I. Financial analysis calculations

FINANCIAL ANALYSIS, 1000's DOLLARS GOLD PRICE - $450

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%	P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
0	235	(235)	1.000	(235)	1.000	(235)	1.000	(235)
1	5193	(5193)	0.909	(4720)	0.877	(4554)	0.847	(4398)
2	-	100	0.826	83	0.769	76	0.718	72
3	-	929	0.751	698	0.675	627	0.609	566
4	-	651	0.683	455	0.592	385	0.516	336
5	-	1072	0.621	665	0.519	556	0.437	468
6	-	625	0.564	353	0.456	285	0.370	231
Total P.W.V.				(2712)		(2858)		(2960)

FINANCIAL ANALYSIS, 1000's DOLLARS GOLD PRICE - $550

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%	P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
0	235	(235)	1.000	(235)	1.000	(235)	1.000	(235)
1	5041	(5041)	0.909	(4582)	0.877	(4420)	0.847	(4269)
2	-	731	0.826	604	0.769	562	0.718	525
3	-	1672	0.751	1256	0.675	1128	0.609	1018
4	-	1278	0.683	873	0.592	756	0.516	659
5	-	1688	0.621	1036	0.519	865	0.437	728
6	-	1244	0.564	701	0.456	567	0.370	460
Total P.W.V.				(347)		(776)		(1112)

FINANCIAL ANALYSIS, 1000's DOLLARS GOLD PRICE - $600

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%	P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
0	235	(235)	1.000	(235)	1.000	(235)	1.000	(235)
1	4965	(4965)	0.909	(4513)	0.877	(4354)	0.847	(4205)
2	-	1021	0.826	843	0.769	785	0.718	733
3	-	1825	0.751	1370	0.675	1231	0.609	1111
4	-	1557	0.683	1063	0.592	921	0.516	803
5	-	1970	0.621	1223	0.519	1022	0.437	820
6	-	1506	0.564	849	0.456	686	0.370	557
Total P.W.V.				602		59		(374)

FINANCIAL ANALYSIS, 1000's DOLLARS GOLD PRICE - $625

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%	P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
0	235	(235)	1.000	(235)	1.000	(235)	1.000	(235)
1	4927	(4927)	0.909	(4479)	0.877	(4320)	0.847	(4173)
2	-	1136	0.826	938	0.769	873	0.718	816
3	-	1978	0.751	1485	0.675	1335	0.609	1204
4	-	1695	0.683	1157	0.592	1003	0.516	875
5	-	2025	0.621	1257	0.519	1050	0.437	884
6	-	1637	0.564	923	0.456	746	0.370	605
Total P.W.V.				1048		454		(22)

FINANCIAL ANALYSIS, 1000's DOLLARS   GOLD PRICE - $650

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%	P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
0	235	(235)	1.000	(235)	1.00	(235)	1.00	(235)
1	4891	(4891)	0.909	(4445)	0.877	(4289)	0.847	(4142)
2	-	1248	0.826	1030	0.769	960	0.718	896
3	-	2120	0.751	1592	0.675	1431	0.609	1291
4	-	1828	0.683	1249	0.592	1082	0.516	943
5	-	2235	0.621	1388	0.519	1159*	0.437	976
6	-	1763	0.564	994	0.456	804	0.370	652*
Total P.W.V.				1573		913		379

FINANCIAL ANALYSIS, 1000's DOLLARS   GOLD PRICE - $750

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%	P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
0	235	(235)	1.000	(235)	1.00	(235)	1.00	(235)
1	4739	(4739)	0.909	(4307)	0.877	(4156)	0.847	(4013)
2	-	1709	0.826	1411	0.769	1314	0.718	1227
3	-	2592	0.751	1946	0.675	1750	0.609	1579
4	-	2339	0.683	1597	0.592	1384	0.516	1206
5	-	2654	0.621	1648	0.519	1377	0.437	1159
6	-	2247	0.564	1267	0.456	1024	0.370	831
Total P.W.V.				3328		2461		1756

FINANCIAL ANALYSIS,

Year	Capital Minus Credit	Cash Flow	P.W.F. @10%
0	235	(235)	1.000
1	4361	(4361)	0.909
2	-	2740	0.826
3	-	3705	0.751
4	-	3381	0.683
5	-	3721	0.621
6	-	3159	0.564
Total P.W.V.			

1000's DOLLARS GOLD PRICE - $1000

P.W.V. @ 10%	P.W.F. @ 14%	P.W.V. @ 14%	P.W.F. @ 18%	P.W.V. @ 18%
(235)	1.00	(235)	1.00	(235)
(3964)	0.877	(3824)	0.842	(3693)
2263	0.769	2107	0.718	1967
2782	0.675	2501*	0.609	2256
2309	0.592	2001	0.516	1744
2310	0.519	1931	0.437	1626
1781	0.456	1440	0.370	1168
7248		5922		4835

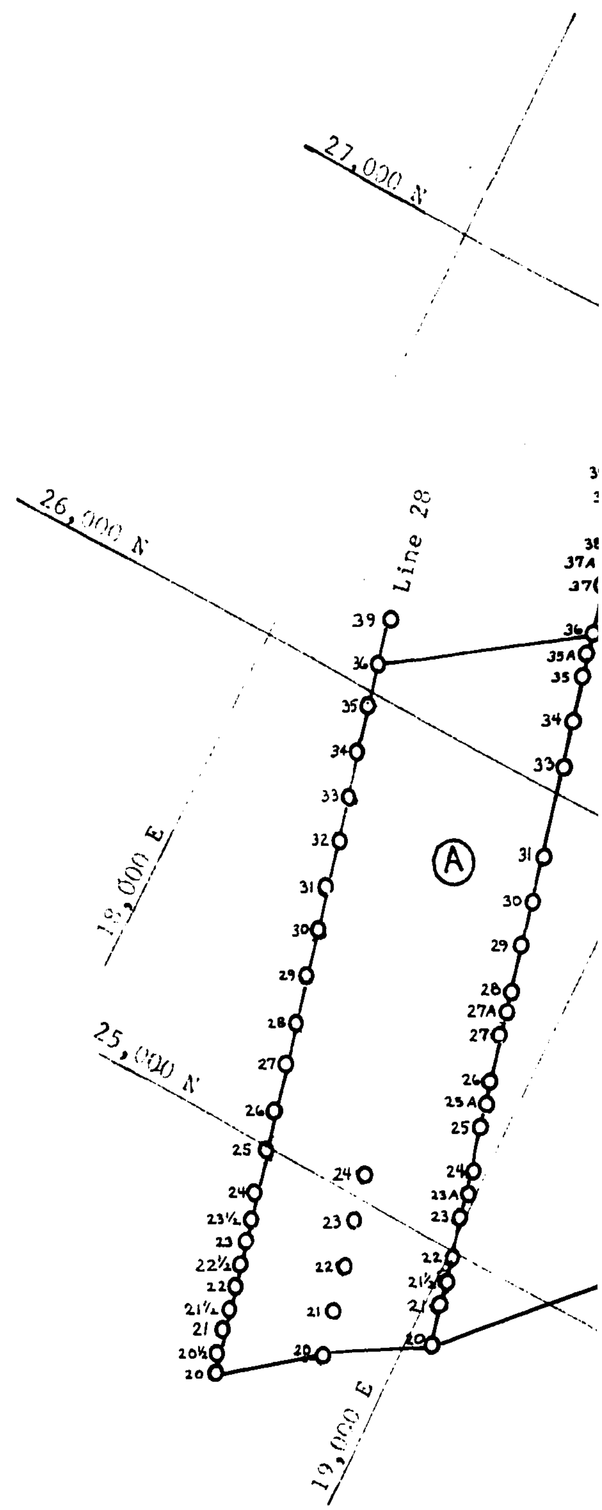
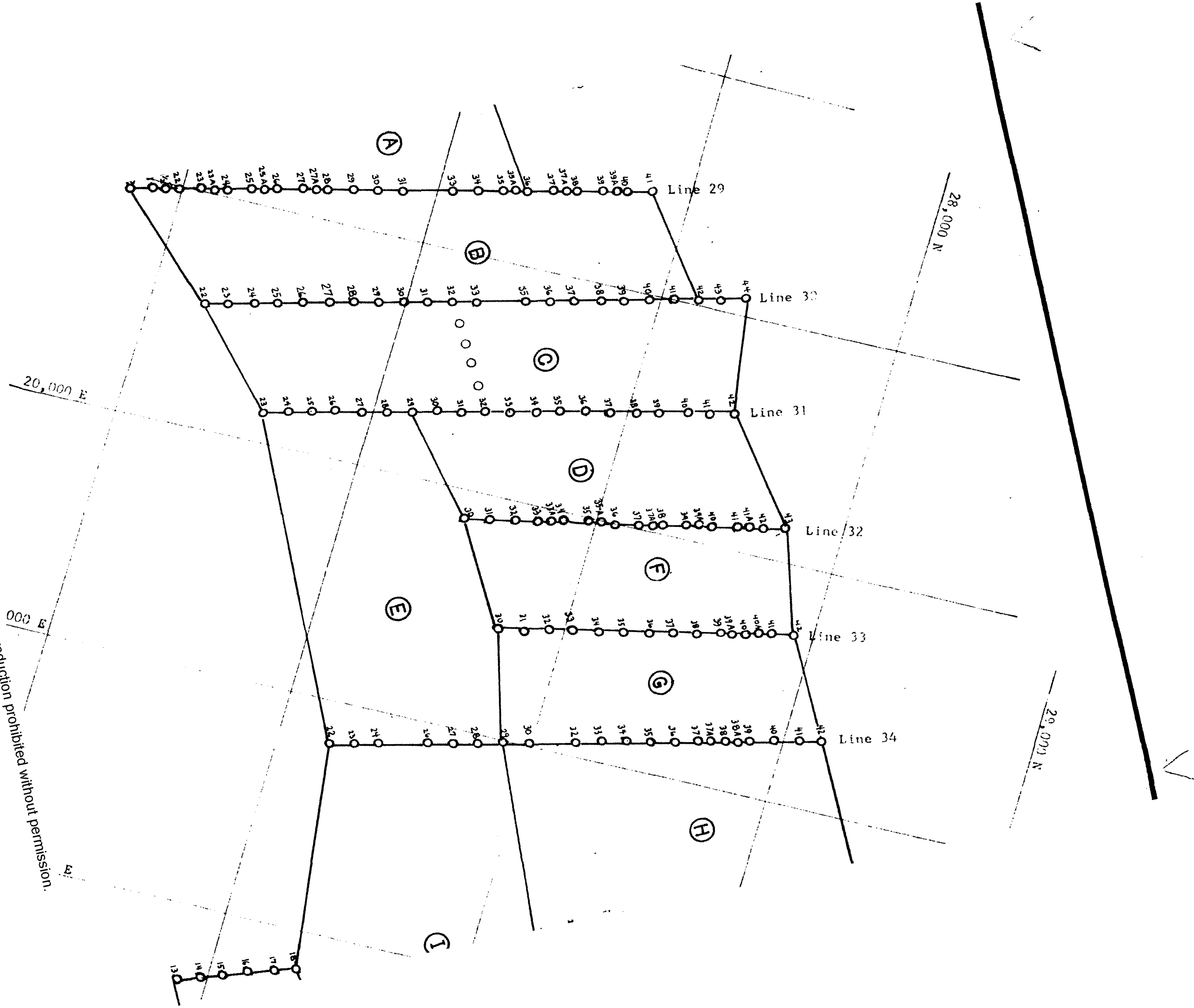


PLATE 1

Positioning and size of blocks used


A
B
C
D
E
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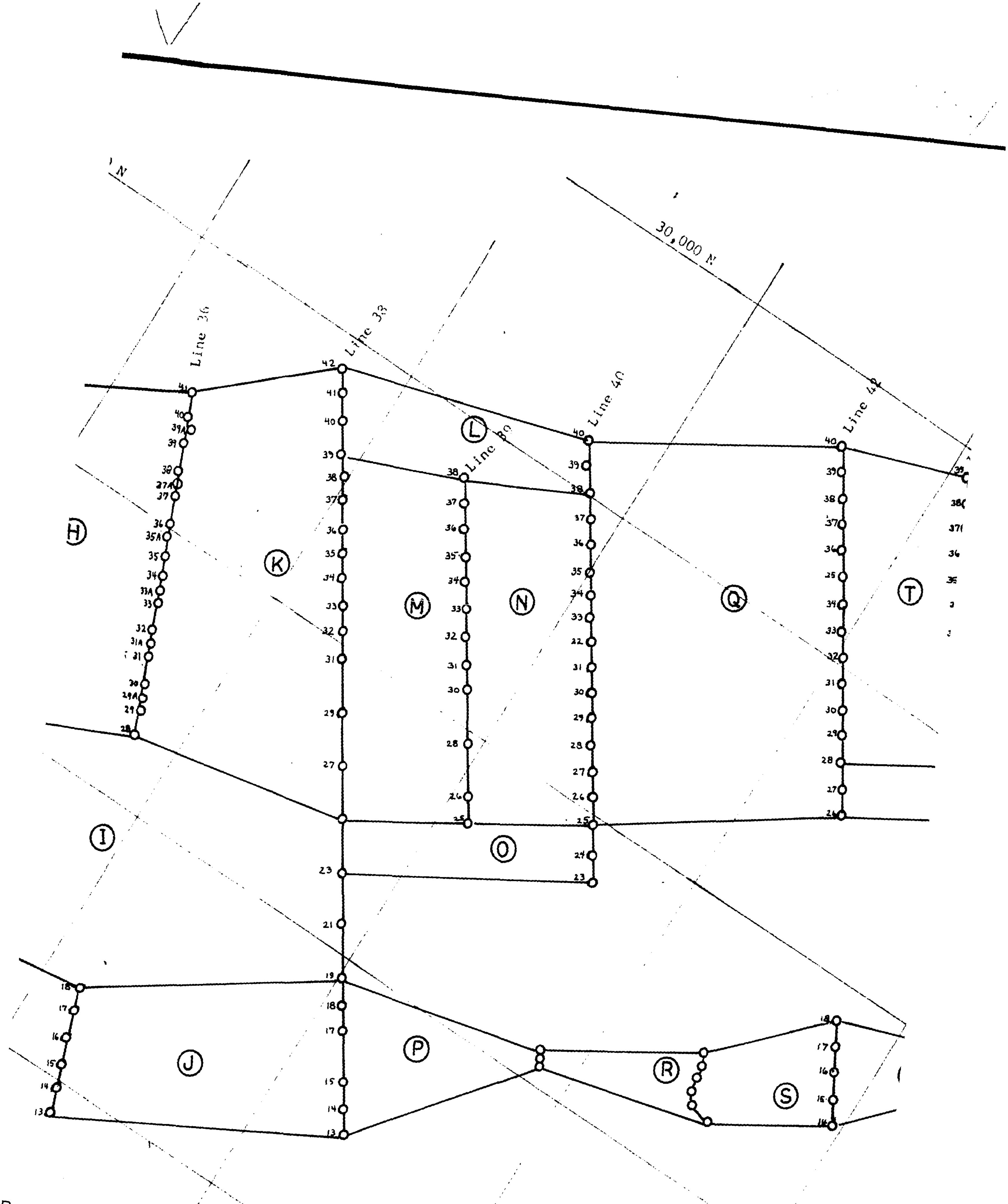
G
H
Line 29
Line 30
Line 31
Line 32
Line 33
Line 34
28,000 N
20,000 E


30,000 N
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Line 39
Line 42
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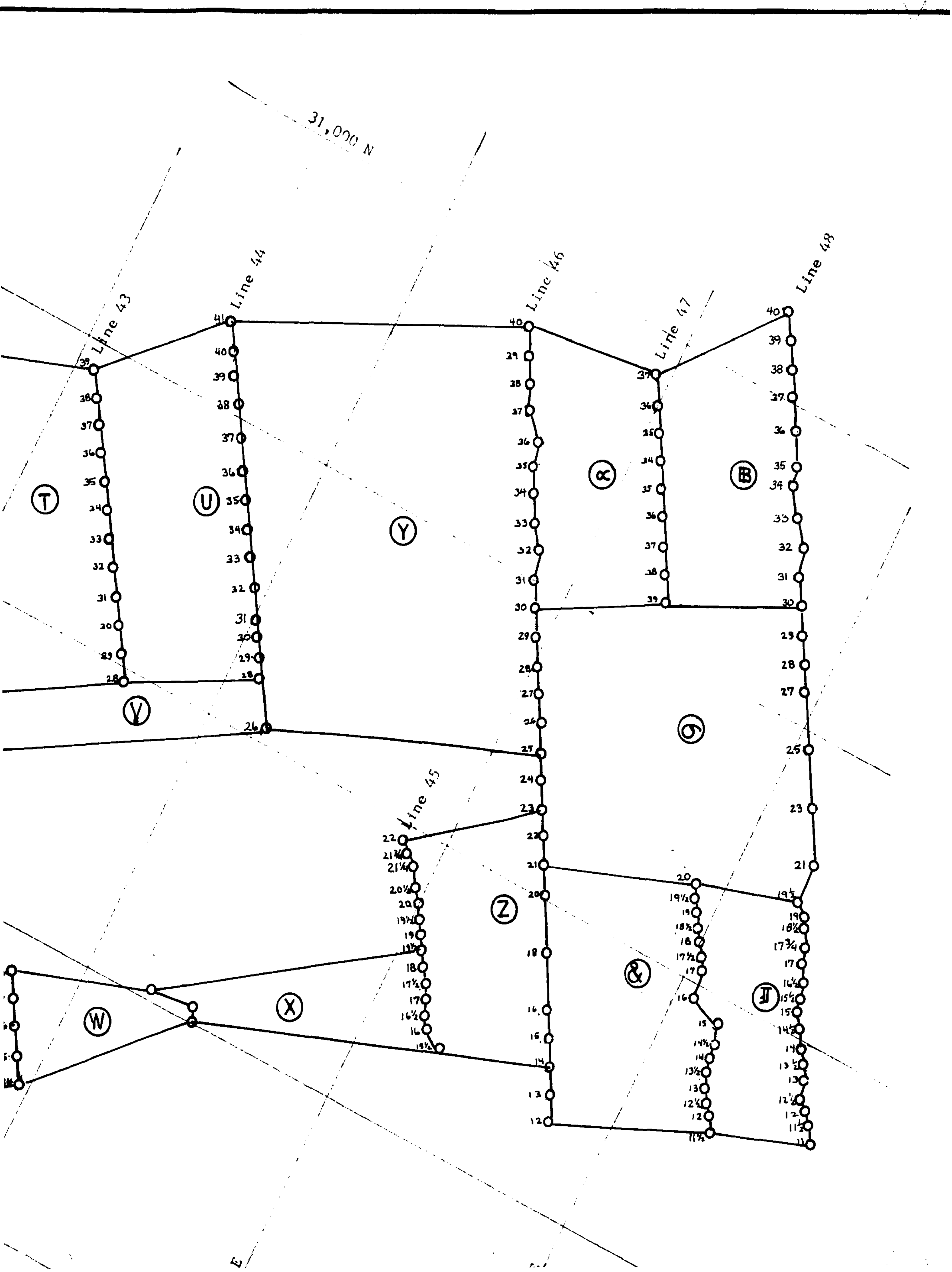
31,000 N
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Line 44
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Line 48
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&
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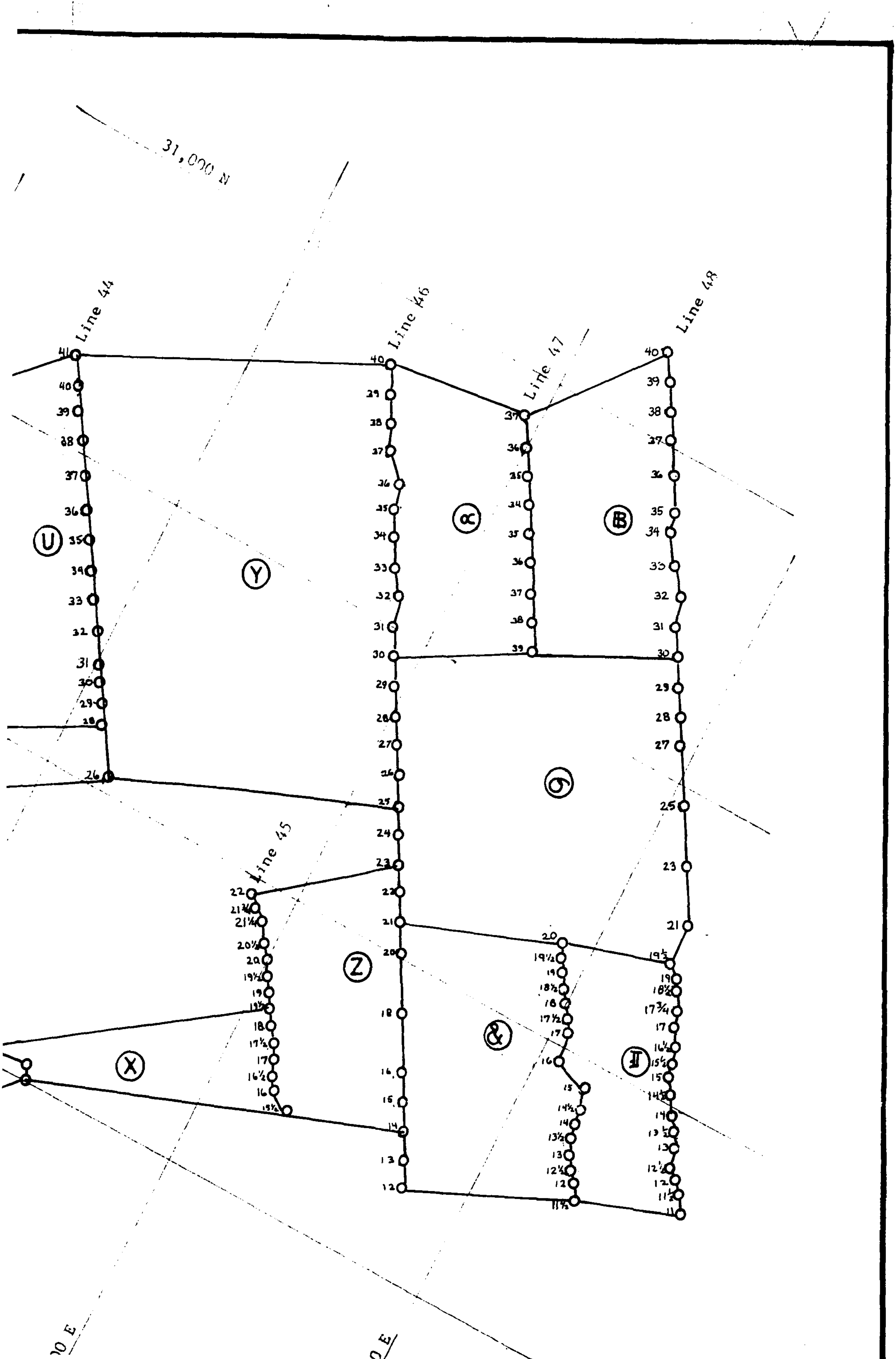
31,000 N
Line 44
Line 46
Line 47
Line 48
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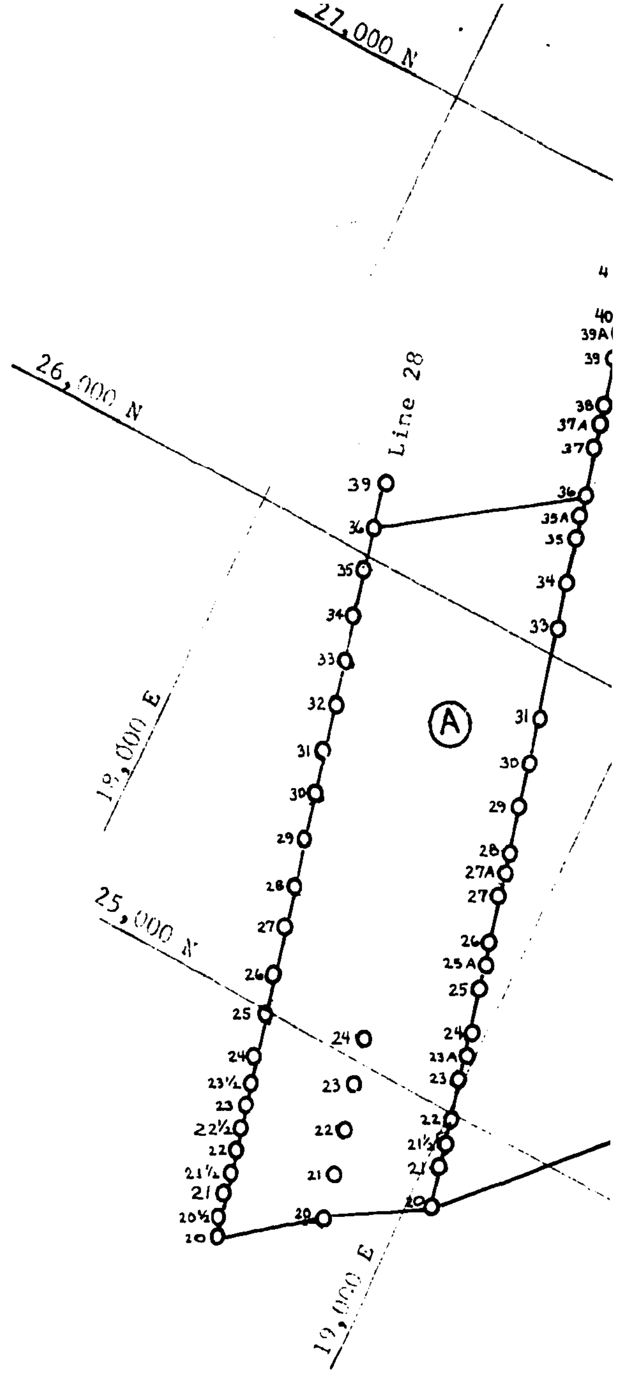
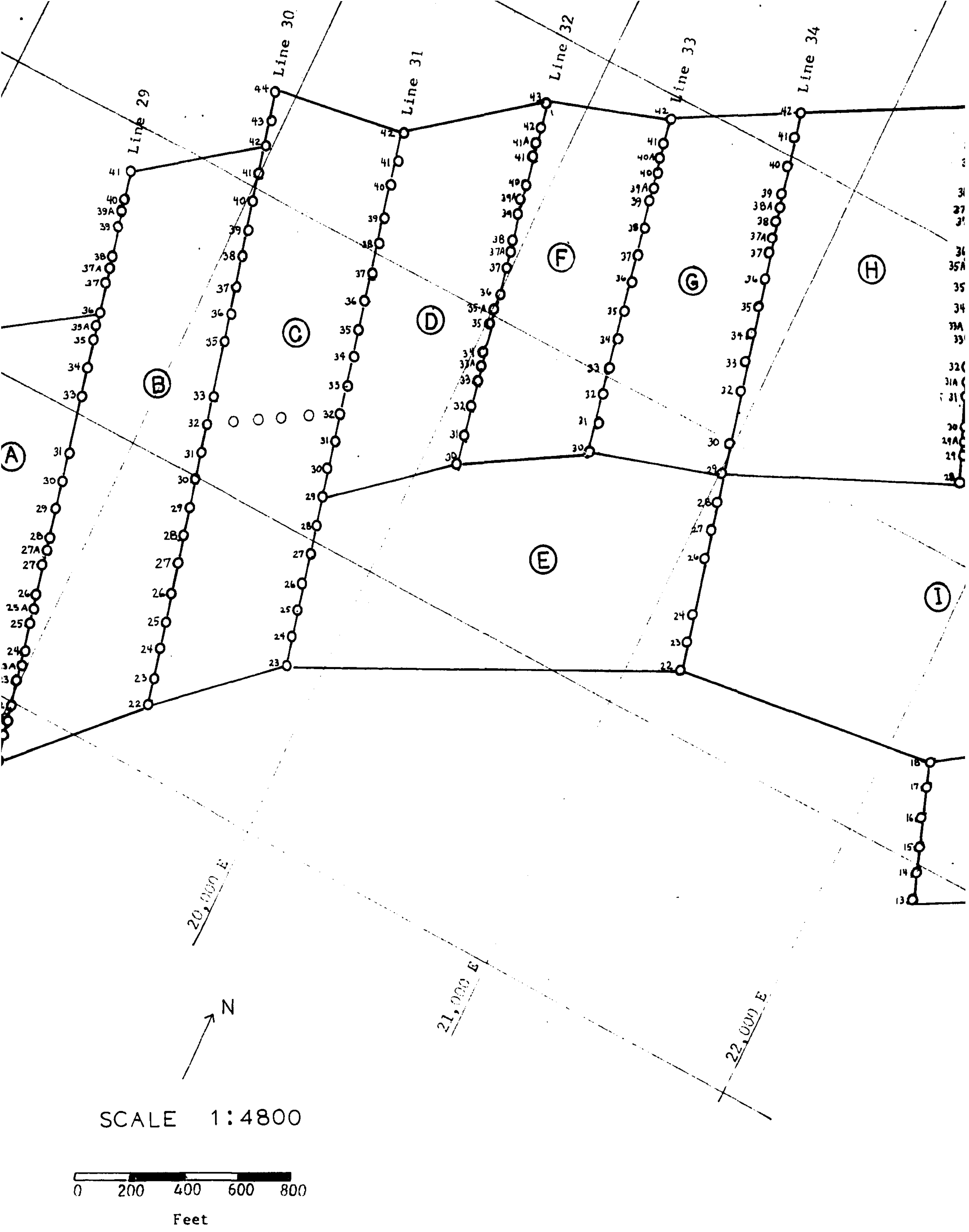


PLATE 1

Positioning and size of blocks used in double-end area valuation, drill lines 28-48, Livengood Creek.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Line 30
Line 31
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H
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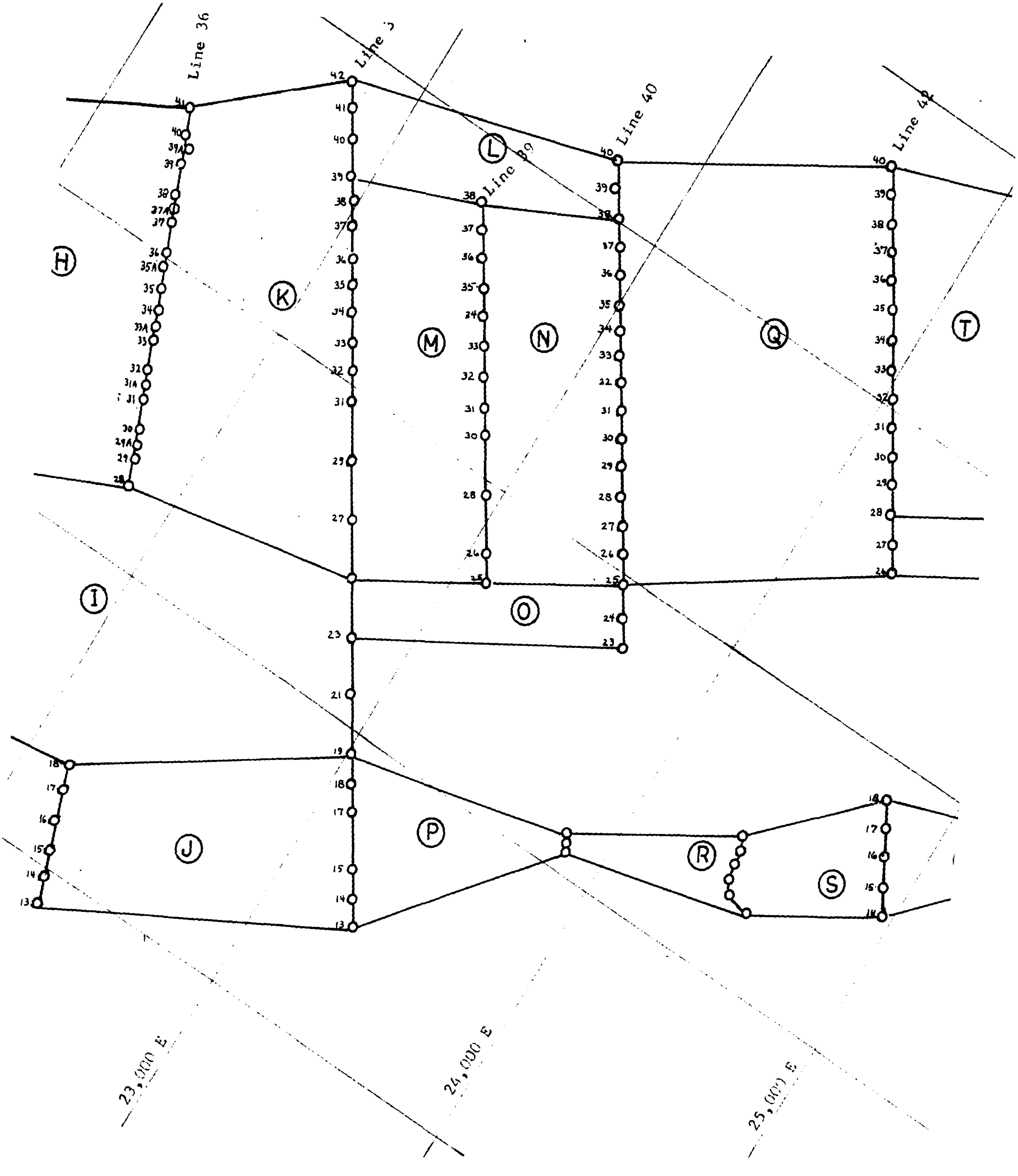
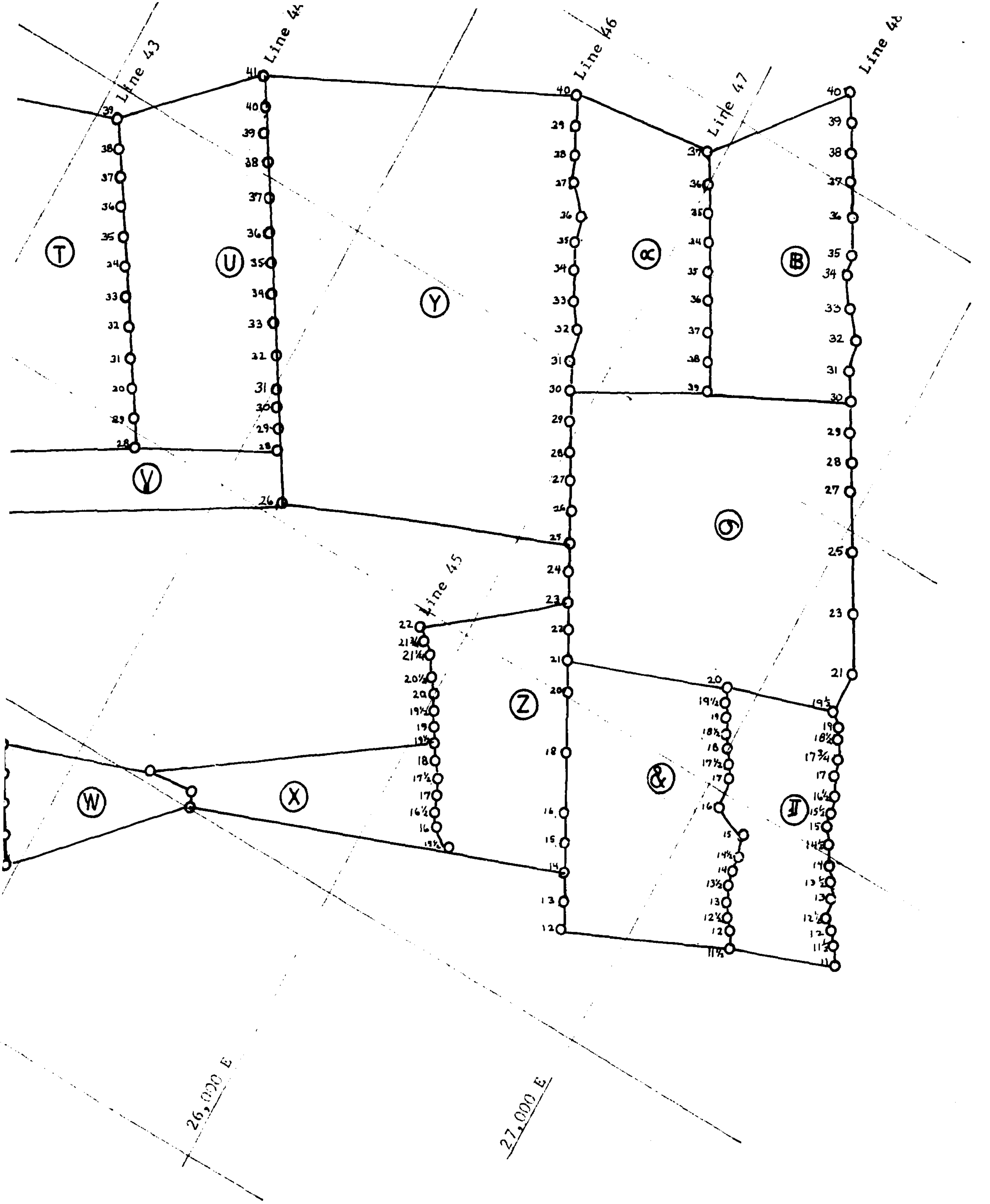
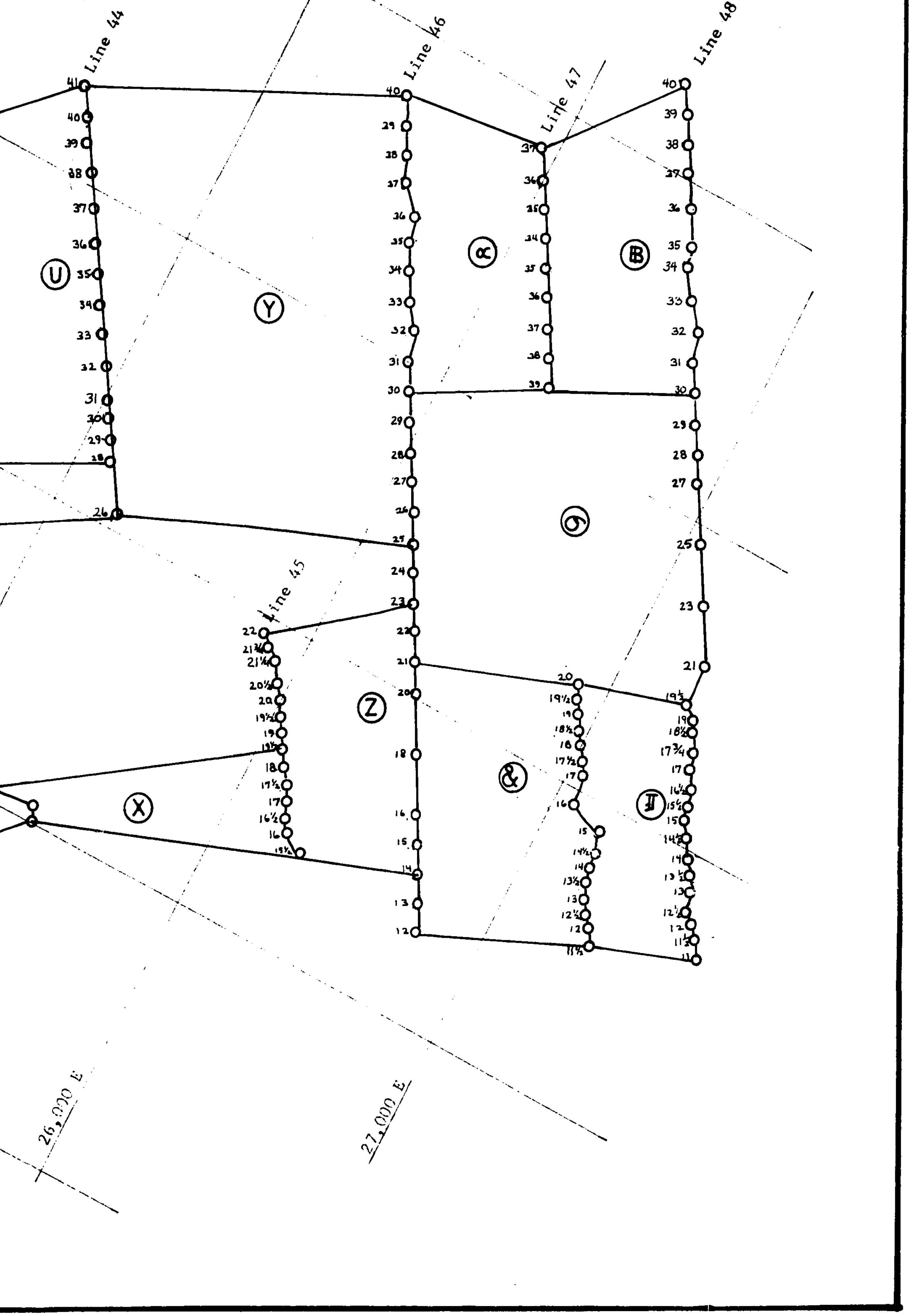
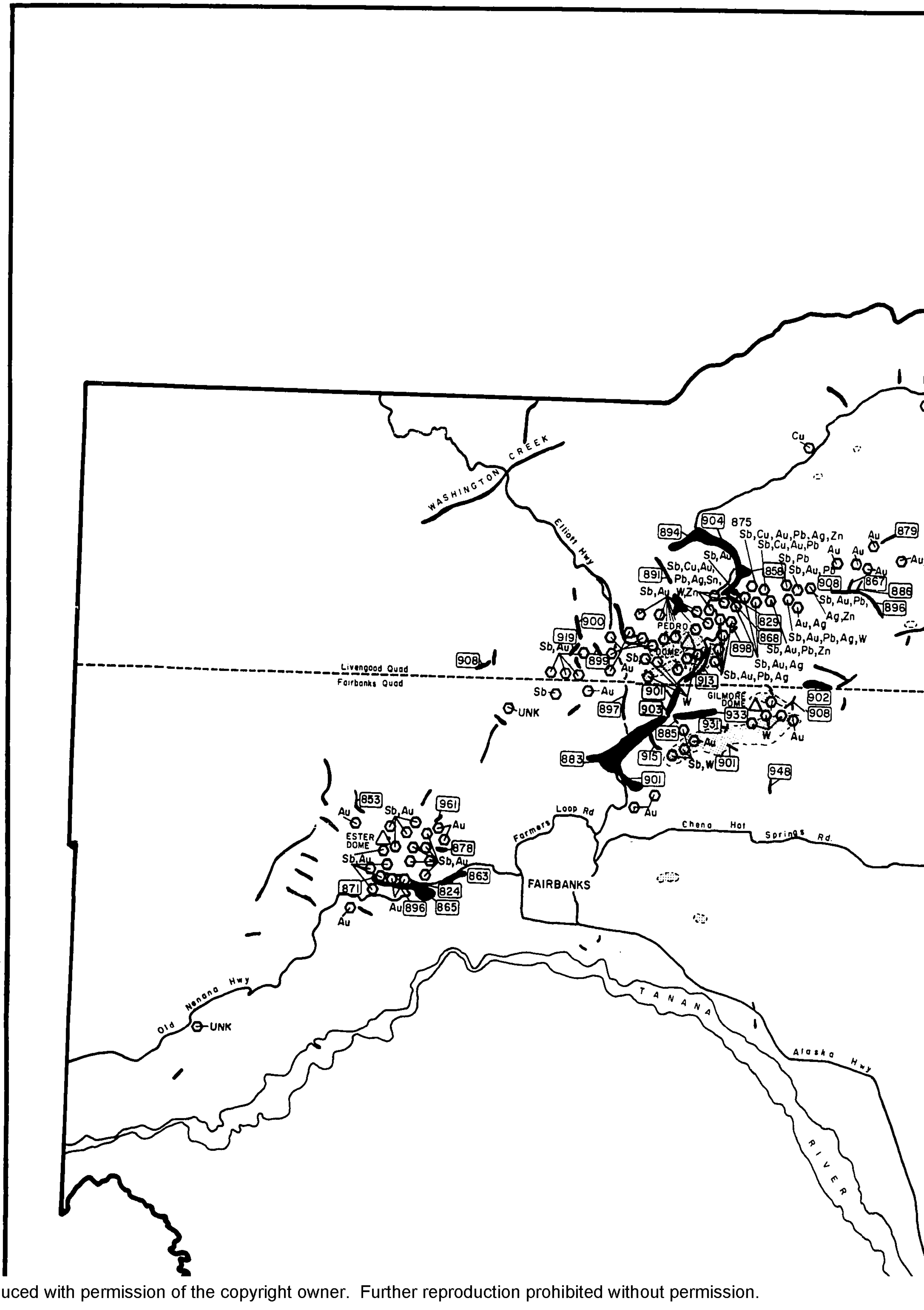
22,000 E
N
SCALE 1:4800
0 200 400 600 800
Feet



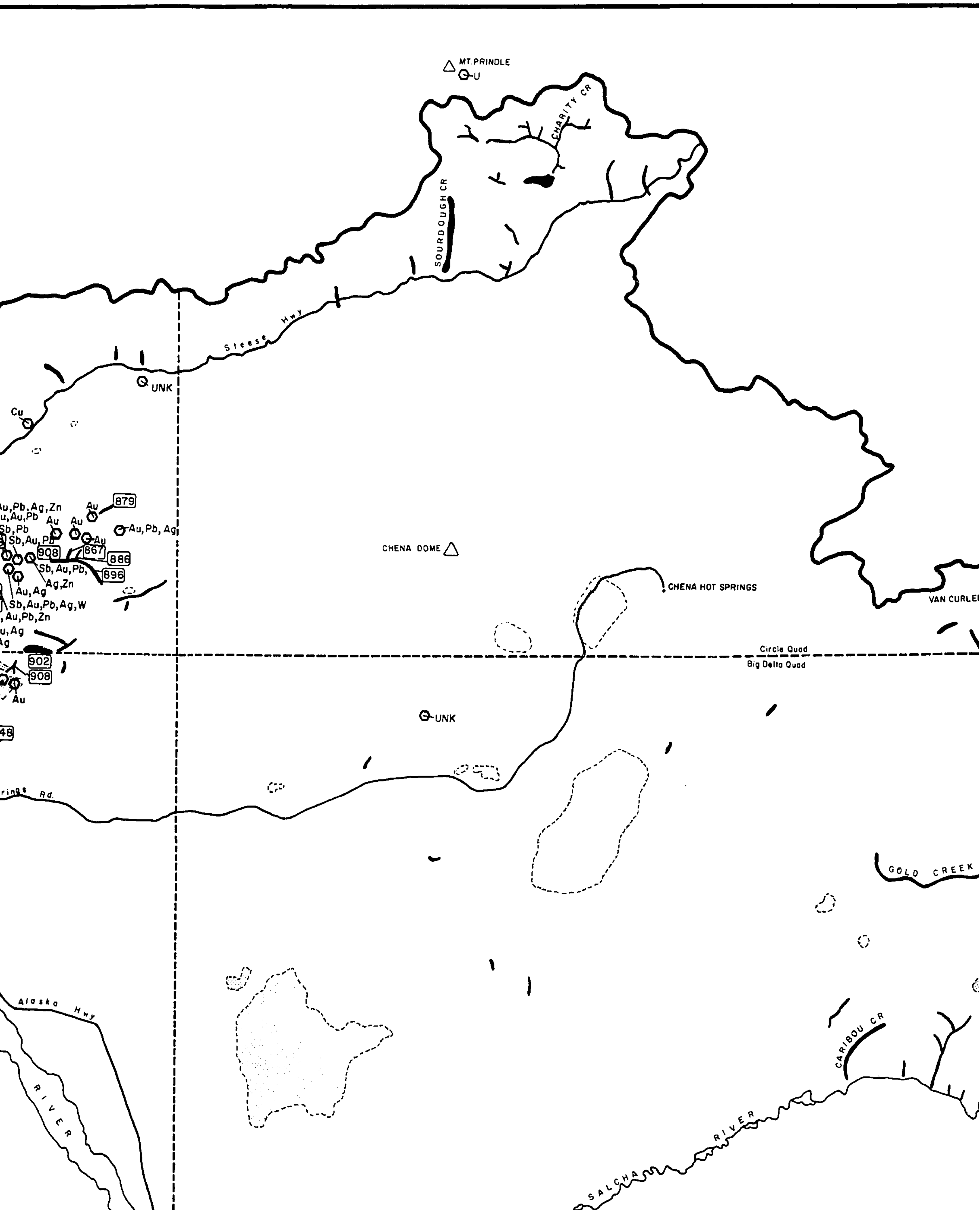
Line 36
Line 3
Line 39
Line 40
Line 42
H
I
J
K
L
M
N
O
P
Q
R
S
T
23,000 E
24,000 E
25,000 E


Line 43
Line 44
Line 46
Line 47
Line 48
Line 45
T
U
Y
Z
W
X
26,000 E
27,000 E

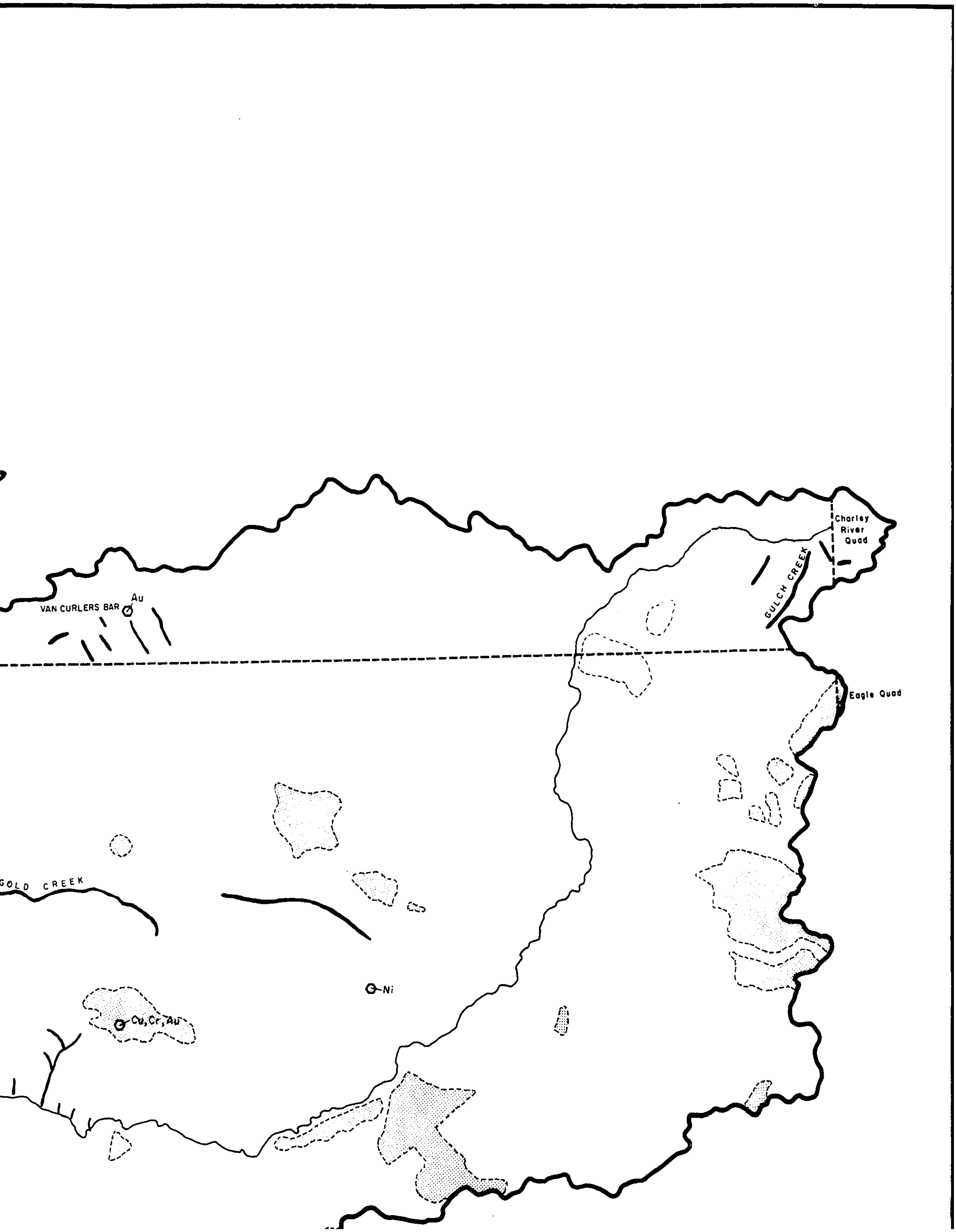

Line 44
Line 45
Line 46
Line 47
Line 48
U
Y
α
B
Z
X
&
26,000 E
27,000 E

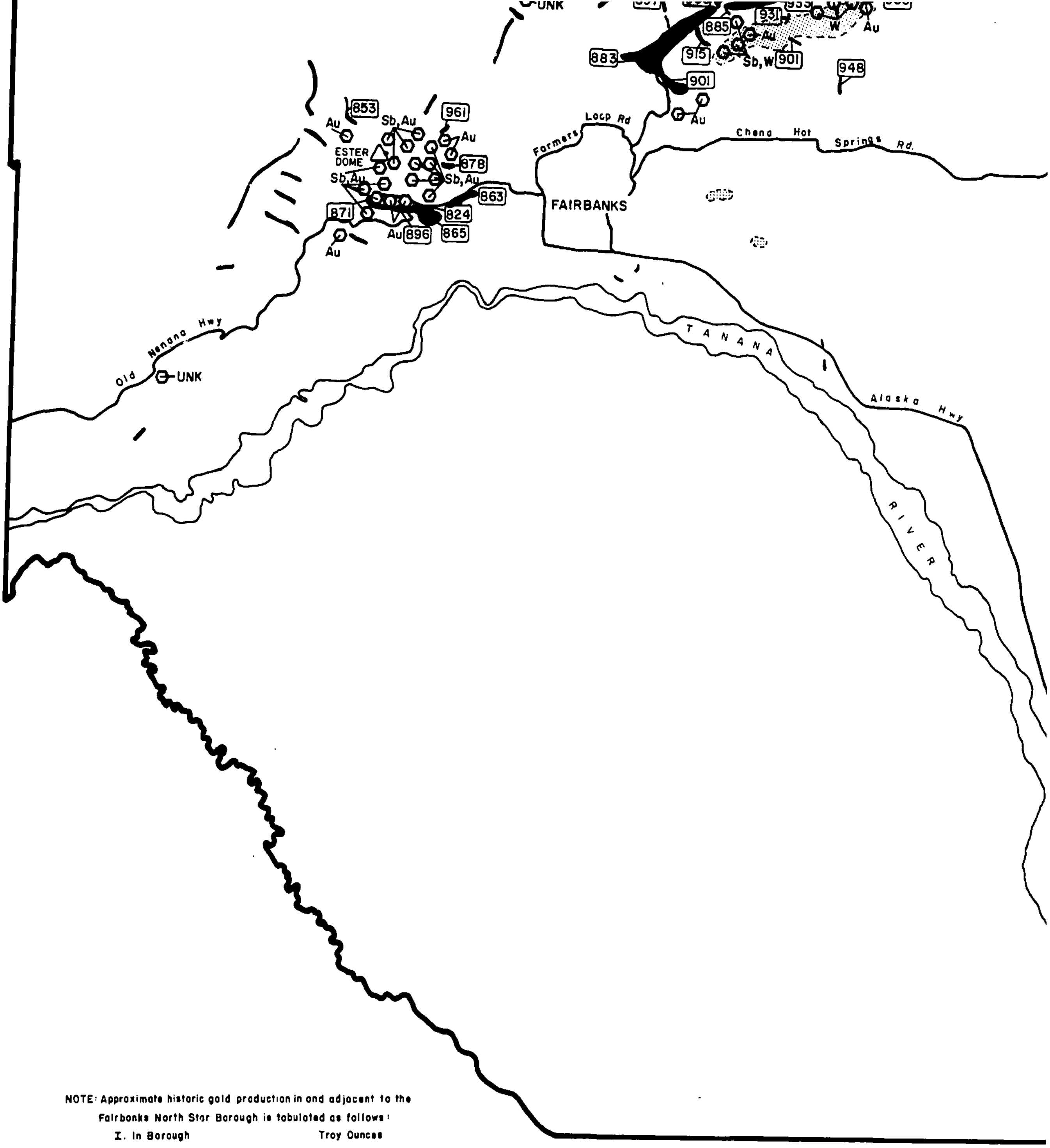


WASHINGTON CREEK
Elliott Hwy
Livengood Quad
Fairbanks Quad
PEDRO DOME
GILMORE DOME
ESTER DOME
FAIRBANKS
Farmers Loop Rd
Chena Hot Springs Rd.
Old Nenana Hwy
TANANA RIVER
Alaska Hwy
UNK
Sb,Cu,Au,Pb,Ag,Zn
Sb,Cu,Au,Pb
Sb,Pb
Sb,Au,Pb
Sb,Cu,Au,
Pb,Ag,Sn,
W,Zn
Sb,Au,Pb,
Ag,Zn
Au,Ag
Sb,Au,Pb,Ag,W
Sb,Au,Pb,Zn
Sb,Au,Ag
Sb,Au,Pb,Ag
Sb,W
Cu



MT. PRINDLE
U
CHARITY CR
SOURDOUGH CR
Steese Hwy
UNK
Cu
Au
879
Au,Pb,Ag,Zn
u,Au,Pb
Sb,Pb
Au
Au
Au
Au,Pb,Ag
Sb,Au,Pb
908
867
886
Sb,Au,Pb,
896
Ag,Zn
Au,Ag
Sb,Au,Pb,Ag,W
,Au,Pb,Zn
u,Ag
Ag
902
908
Au
48
CHENA DOME
CHENA HOT SPRINGS
VAN CURLE
Circle Quad
Big Delta Quad
UNK
Rd.
GOLD CREEK
Alaska Hwy
RIVER
CARIBOU CR
SALCHA RIVER


VAN CURLERS BAR
Au
GULCH CREEK
Charley River Quad
Eagle Quad
GOLD CREEK
Ni
Cu, Cr, Au



NOTE: Approximate historic gold production in and adjacent to the Fairbanks North Star Borough is tabulated as follows:

	Troy Ounces
I. In Borough	
1. Fairbanks District	7,465,000
2. Richardson District	95,000
II. Adjacent to Borough (within 75 air miles)	
1. Hot Springs District	448,000
2. Rampart District	87,000
3. Tolovona	375,000
4. Bonnifield District	45,000
5. Circle District	730,000
Total	9,245,000

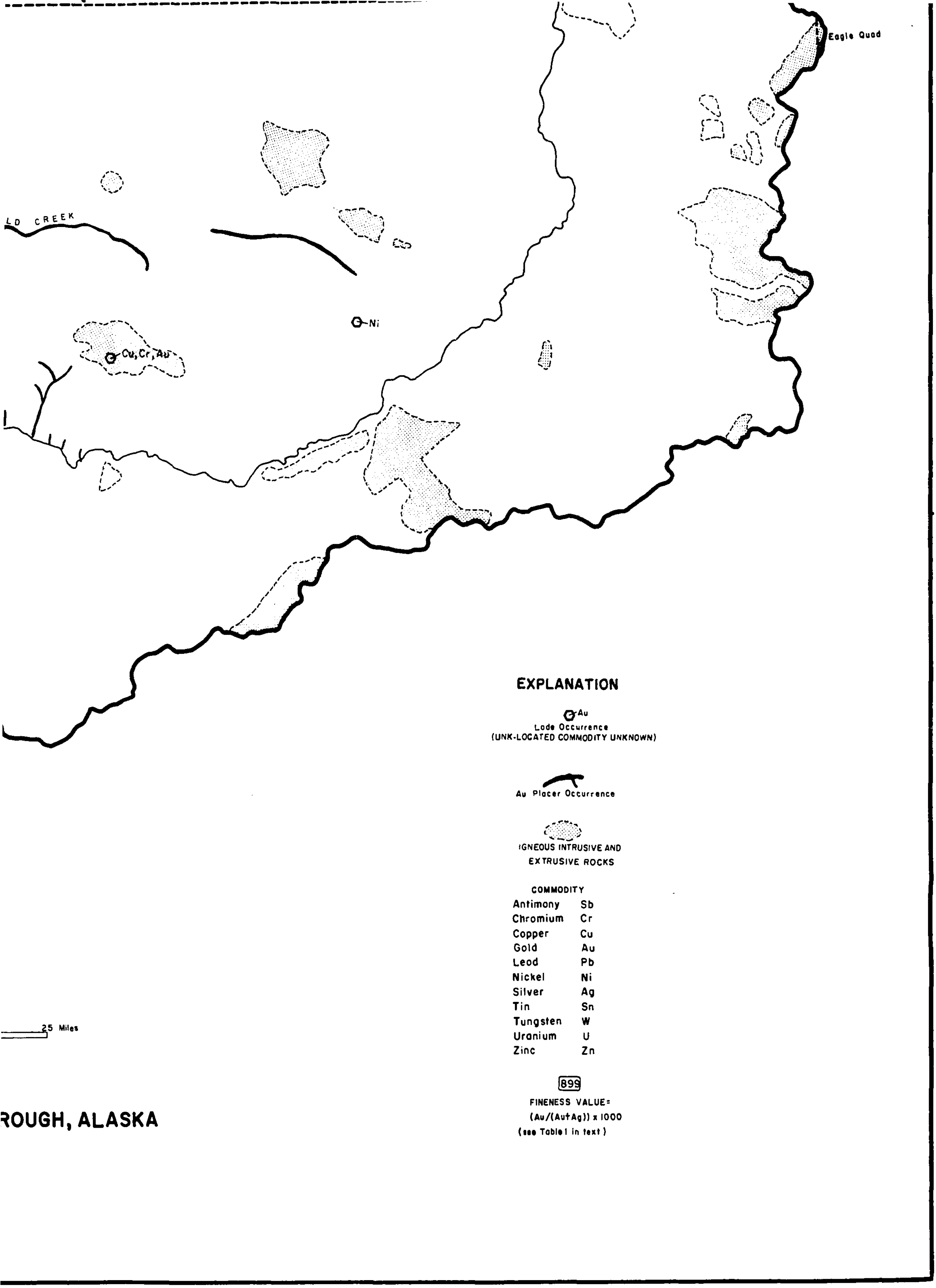
Source: Robinson, M.S. and Bundtzen, T.K., 1979, Historic gold production in Alaska-A minisummary: Alaska Division of Geological and Geophysical Surveys Mines and Geology Bull. v. 28, no. 3, p. 1-4.

PLACER GOLD FINENESS VALUES &
MINERAL RESOURCES OF THE FAIRBANKS NORTH STAR BOROUGH, AL

Compiled by
Paul A. Metz

Mineral Industry Research Laboratory

1977
REVISED 1981



Eagle Quad
LD CREEK
Ni
Cu, Cr, Au
EXPLANATION
Au
Lode Occurrence
(UNK-LOCATED COMMODITY UNKNOWN)
Au Placer Occurrence
IGNEOUS INTRUSIVE AND
EXTRUSIVE ROCKS
COMMODITY
Antimony Sb
Chromium Cr
Copper Cu
Gold Au
Lead Pb
Nickel Ni
Silver Ag
Tin Sn
Tungsten W
Uranium U
Zinc Zn
899
FINENESS VALUE=
(Au/(Au+Ag)) x 1000
(see Table 1 in text)
25 Miles
ROUGH, ALASKA

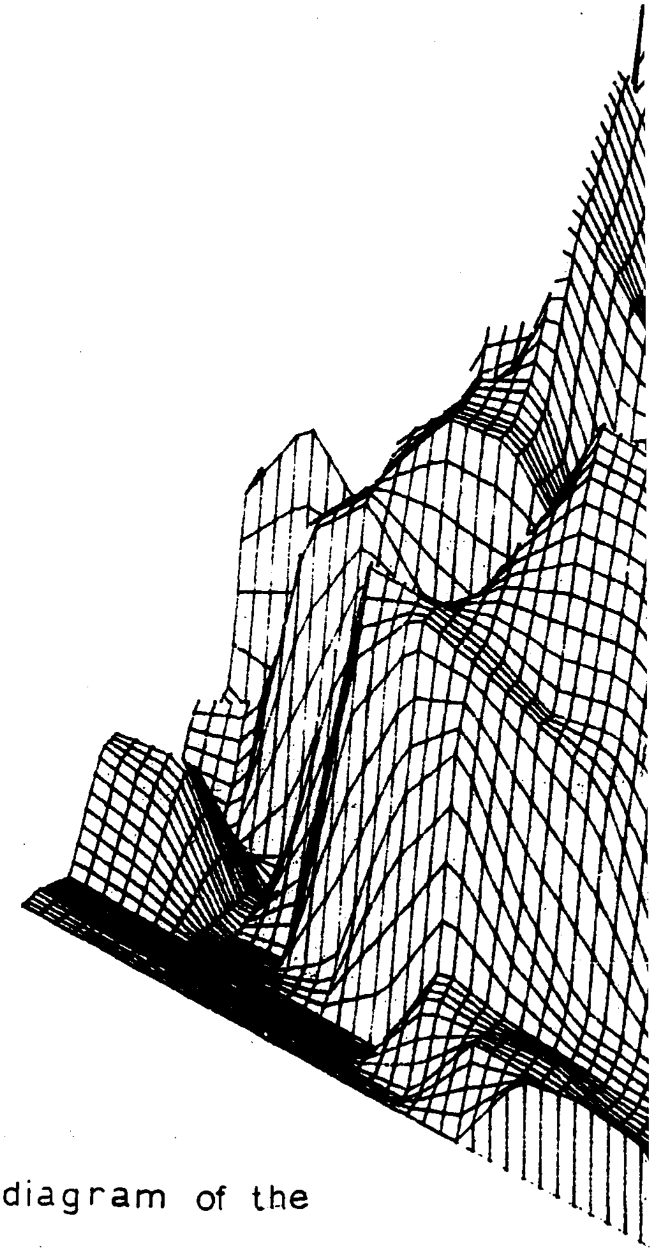
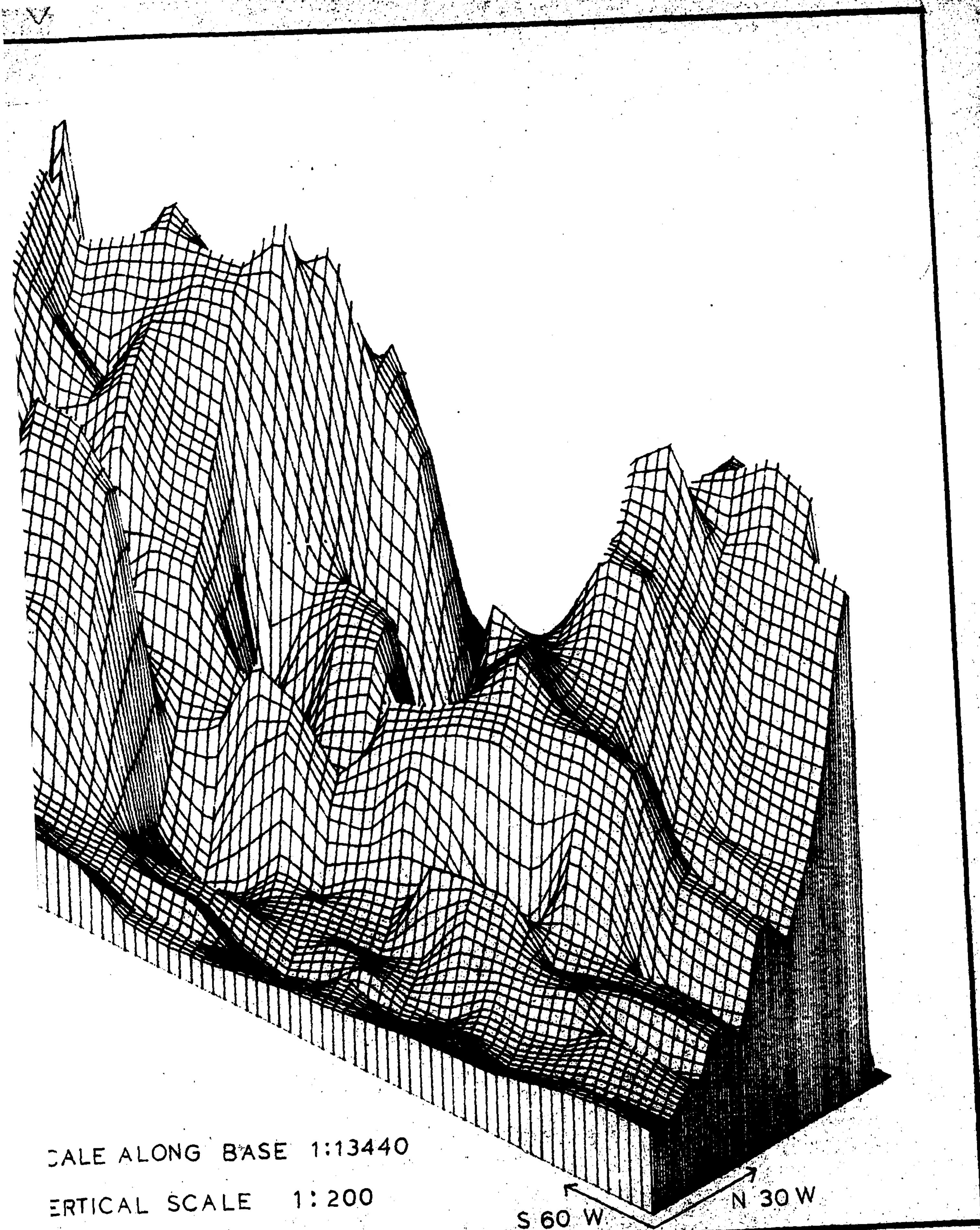


PLATE 2

Perspective block diagram of the overburden thickness between drill lines 28 and 48, Livengood Creek.

SCAL

VERTI



ALE ALONG BASE 1:13440
ERTICAL SCALE 1:200
S 60 W
N 30 W

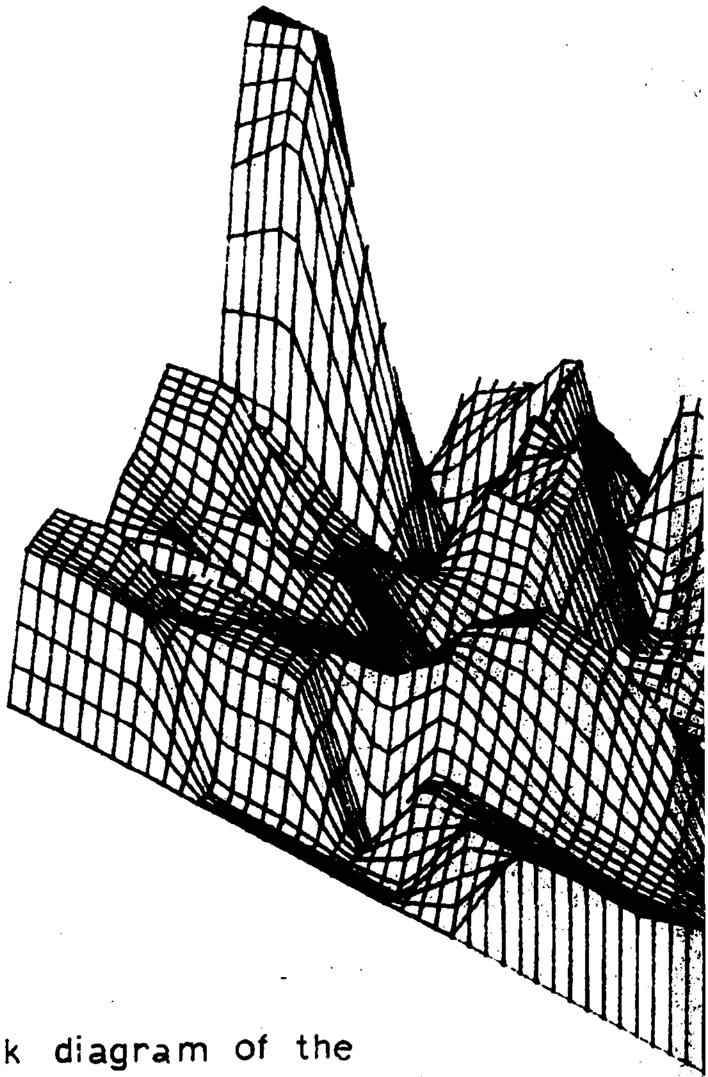
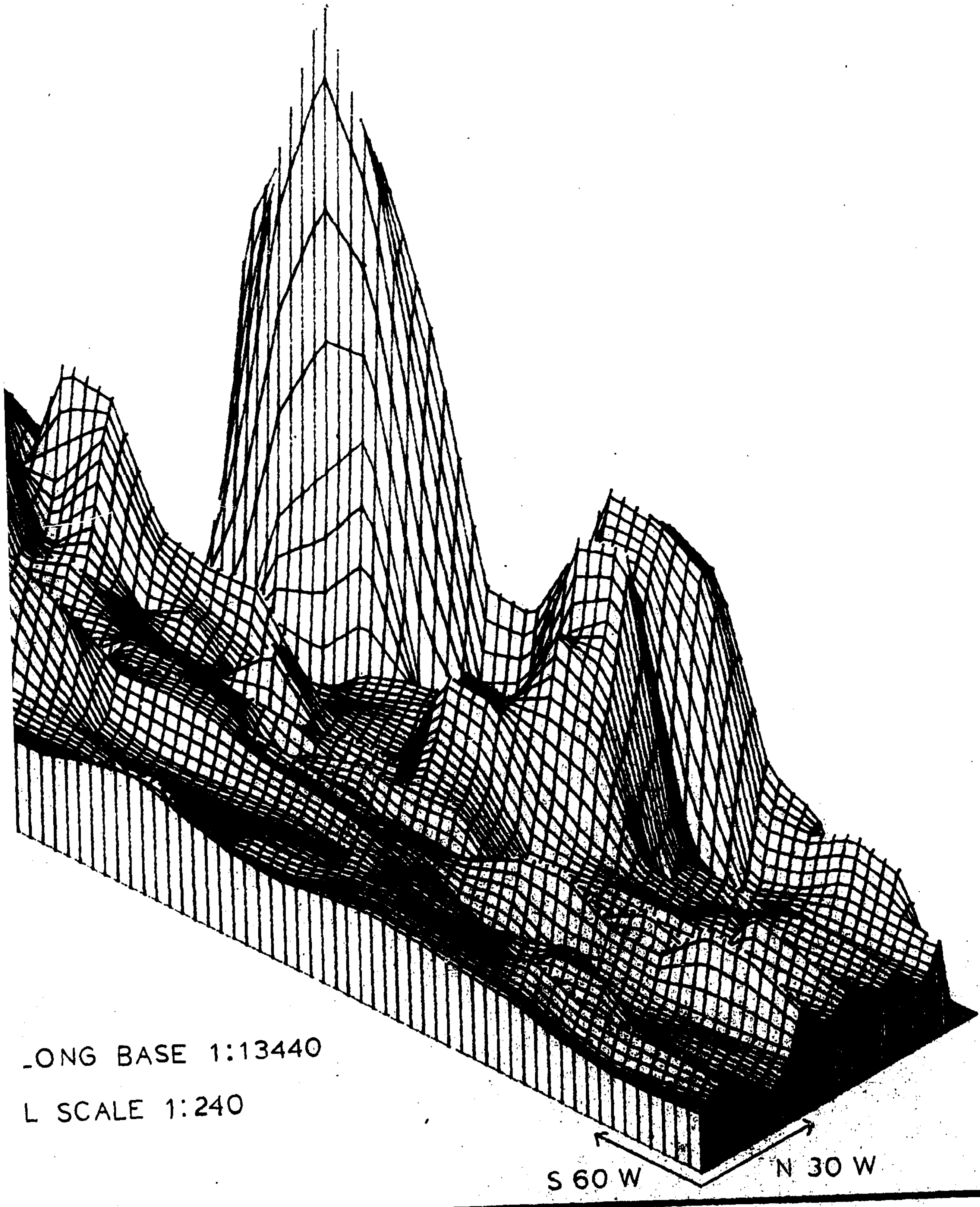


PLATE 3

Perspective block diagram of the gravel thickness between drill lines 28 and 48, Livengood Creek.

SCALE ALONG

VERTICAL SC



_ONG BASE 1:13440
L SCALE 1:240
S 60 W
N 30 W

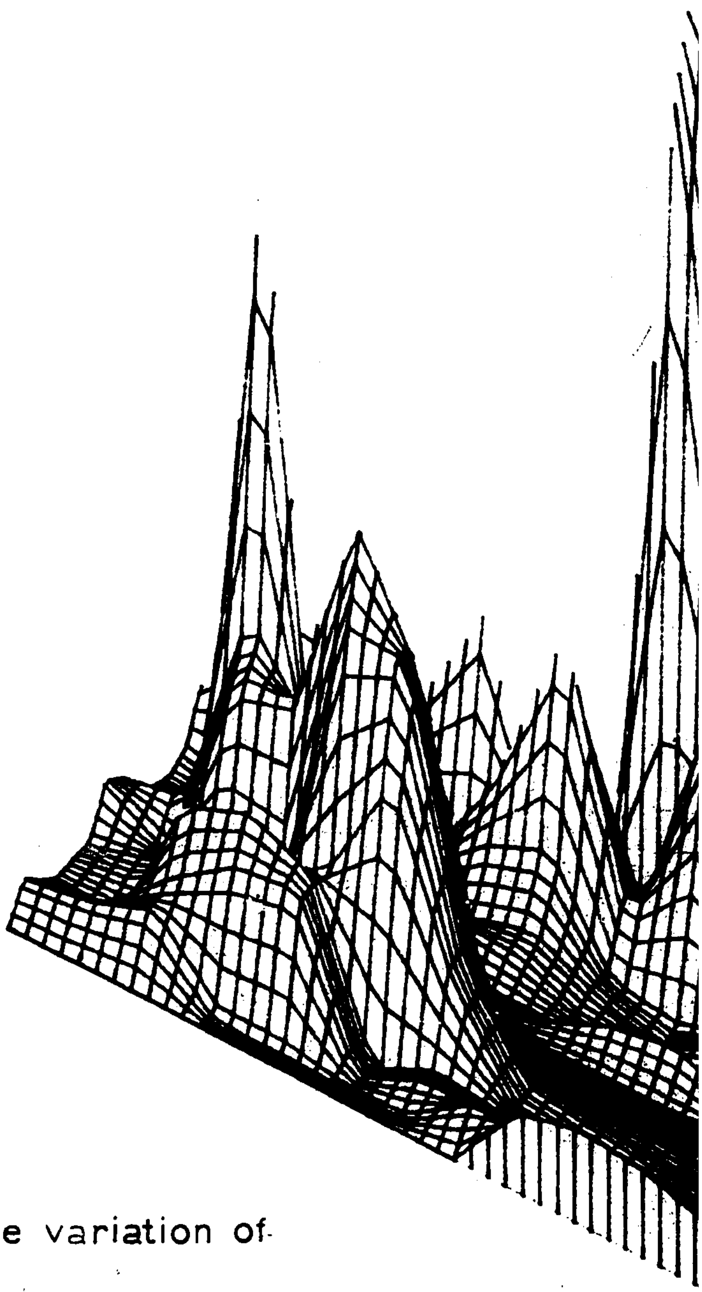
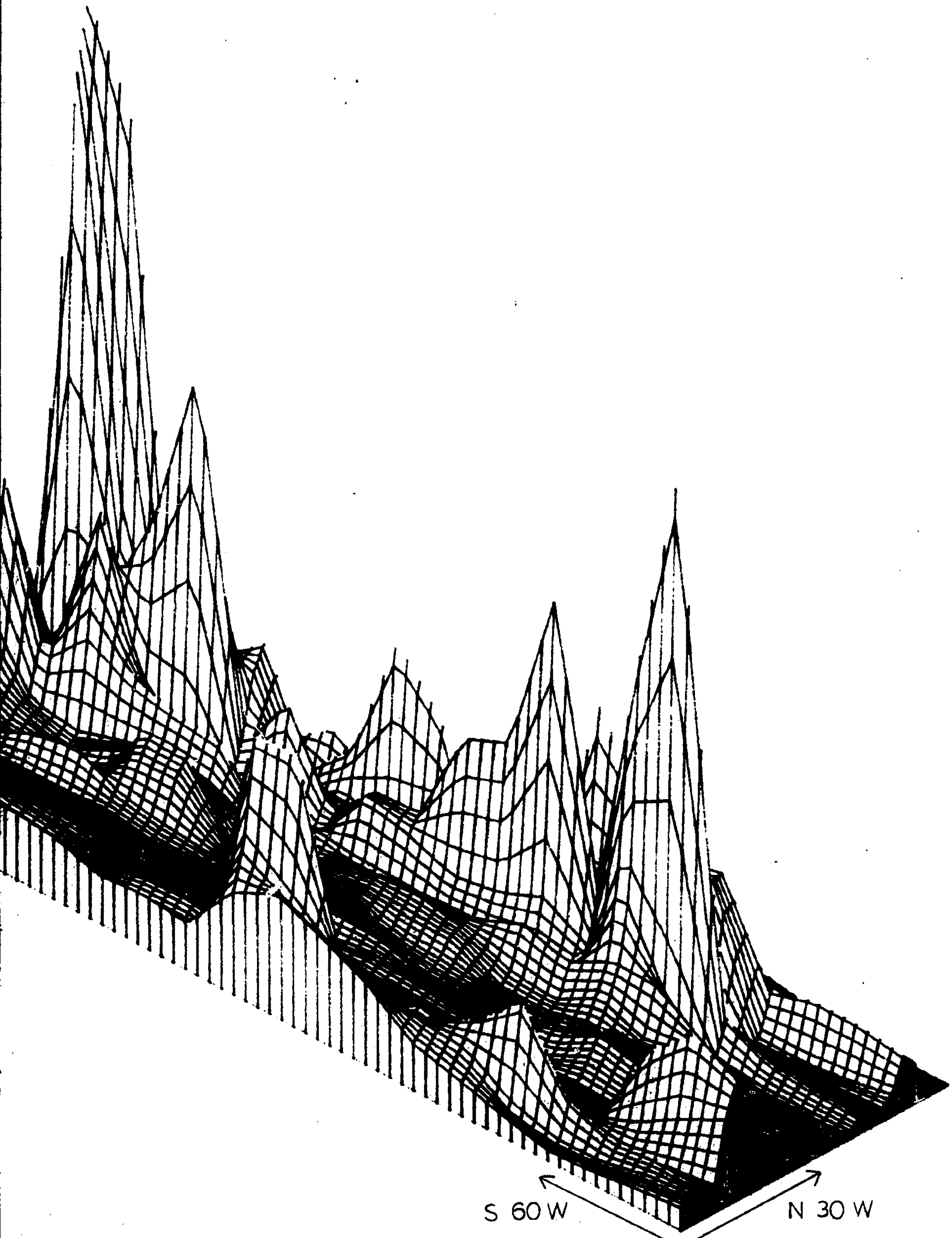


PLATE 4

Perspective block diagram of the variation of gold values along bedrock ($/S.F.) between drill lines 28 and 48, Livengood Creek.

SCALE ALONG BASE 1:13440
VERTICAL SCALE 1" = $2/S.F.


S 60 W
N 30 W